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E. W. NELSON, Chief

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PROPAGATION OF WILD-DUCK FOODS.

By W. L. McAtee, *Assistant Biologist.*

CONTENTS.

	Page.
Introduction	1
Wild rice	4
Wild celery	9
Pondweeds	13
Enemies of wild rice, wild celery, and pondweeds	20
The arrowheads	21
Delta potato	21
Wapato	24
Chufa	28
Wild millet	32
The waterlily group	35
Banana waterlily	36

INTRODUCTION.

Information concerning the propagation of valuable wild-duck foods is constantly requested by State game commissions, game protective associations, and sportsmen's clubs, and by individuals interested in the protection, preservation, and propagation of waterfowl. The Biological Survey has endeavored to meet the demand by issuing three publications[1] on the more important food plants of wild ducks, by correspondence relating to local problems, and in certain cases by special examination and report. The bulletins thus far published have contained accounts of the value, nature, range, and methods of propagation of 19 groups of plants comprising more than 60 species.

The present bulletin is a revision of the first two of these publications and discusses the following plants suitable for wild-duck food: Wild rice, wild celery, pondweeds, arrowheads (especially delta potato and wapato), chufa, wild millet, and waterlilies (especially the banana waterlily).[1] The kinds of foods that can be recommended for propagation must practically be restricted to those already on the market. This fact has controlled the selection of the varieties discussed in previous publications. It is highly desirable that dealers increase the scope of their stock so that persons interested may obtain seeds or other parts necessary for the propagation of additional kinds, a number of which are just as valuable as food for wild ducks as some now offered for sale. The best of these are shown in Table I.

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[1] Biol. Surv. Circ. No. 81, Sept. 9, 1911; and U. S. Dept. Agr. Bulls. No. 58, Feb. 7, 1914, and No. 205, May 20, 1915.

Note.—This bulletin is for general distribution among persons and organizations interested in the protection, preservation, and propagation of waterfowl. It supersedes Biological Survey Circular No. 81, dealing with wild rice, wild celery, and pondweeds; and Department Bulletin No. 58, dealing with delta potato, wapato, chufa, wild millet, and banana waterlily.

TABLE I.—*Wild-duck foods not at present on the market.*

No.	Common name.	Scientific name.	General range.	Local conditions.
1	Bur reed	*Sparganium eurycarpum*	United States	Marshes.
2	Do	*Sparganium angustifolium*	Northern States	Quiet water.[2]
3	Pondweed	*Potamogeton heterophyllus*	Northern Hemisphere	Do.
4	Do	*Potamogeton pusillus*	do	Do.
5	Do	*Potamogeton filiformis*	Northern States	Do.
6	Do	*Potamogeton interior*	Western States	Do.
7	Western widgeon-grass	*Ruppia occidentalis*	do	Saline lakes.
8	Horned pondweed	*Zannichellia palustris*	Cosmopolitan	Fresh or brackish water.
9	Bushy pondweed	*Naias flexilis*	Northern Hemisphere	Quiet water.
10	Arrowhead	*Sagittaria longiloba*	Western States	Shallow water.
11	Do	*Sagittaria rigida*	Northern States	Do.
12	Do	*Sagittaria teres*	Atlantic coast	Do.
13	Do	*Sagittaria graminea*	Eastern States	Do.
14	Do	*Sagittaria papillosa*	Gulf States	Do.
15	Grass	*Panicum condensum*	Eastern States	Swamps.
16	Switch grass	*Panicum virgatum*	United States	Wet soil.
17	Salt-marsh grass	*Spartina cynosuroides*	Atlantic coast	Salt marshes.
18	Cord grass	*Spartina michauxiana*	Eastern States	Fresh or brackish marshes.
19	Do	*Spartina gracilis*	Western States	Saline soil.
20	Meadow grass	*Panicularia nervata*	United States	Wet soil.
21	Bulrush	*Scirpus americanus*	Cosmopolitan	Fresh or brackish marshes.
22	Do	*Scirpus validus*	North America	Shallow water.
23	Do	*Scirpus occidentalis*	United States	Do.
24	Do	*Scirpus paludosus*	do	Salt marshes.
25	Do	*Scirpus robustus*	Atlantic coast	Do.
26	Do	*Scirpus fluviatilis*	Northern States	Shallow water.
27	Do	*Scirpus cubensis*	Gulf States	Swamps.
28	Saw grass	*Cladium effusum*	Southeastern States	Coast marshes.
29	Sedge	*Carex decomposita*	Eastern States	Swamps.
30	Wampee[3]	*Peltandra virginica*	do	Shallow water.
31	Pickerel weed[3]	*Pontederia cordata*	do	Do.

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[1] Other plants are included in Department Bulletin No. 205 (25 p., 23 figs.), as follows: Musk grass, duckweeds, frogbit, thalia, water elm, swamp privet, eelgrass, widgeon-grass, watercress, waterweed, and coontail.

[2] Where not specified, fresh water is to be understood.

[3] This plant now on sale by some dealers.

TABLE I.—*Wild-duck foods not at present on the market*—Continued.

No.	Common name.	Scientific name.	General range.	Local conditions.
32	Smartweed	*Polygonum amphibium*	United States	Shallow water.
33	Do	*Polygonum pennsylvanicum.*	do	Wet soil.
34	Do	*Polygonum opelousanum*	Eastern States	Do.
35	Do	*Polygonum hydropiperoides.*	United States	Do.
36	Do	*Polygonum hydropiper*	Northern Hemisphere.	Do.
37	Do	*Polygonum punctatum*	North America	Do.
38	Do	*Polygonum sagittatum*	United States	Do.
39	Saltwort	*Salicornia europæa*	Northern Hemisphere.	Salt marshes and sea beaches.
40	Do	*Salicornia ambigua*	Both coasts	Do.
41	Water primrose	*Jussiæa leptocarpa*	Southeastern States	Swamps.
42	Water pennywort	*Hydrocotyle umbellata*	United States	Do.

Were all these plants available to persons interested in improving the food supply of wild ducks the outlook would be most satisfactory, for from these and the plants hitherto listed and described something of value could be selected for almost any environmental condition.

Classifying the plants recommended for propagation according to the conditions to which they are suited, we have as a salt-water plant, eelgrass; for brackish water, widgeon-grass, sago pondweed, and wild celery, all of which also grow in fresh water, the last two abundantly; for fresh water with slight current, wild rice, wild celery, all the pondweeds, and watercress; for fresh water that is quiet except for wind currents, pondweeds, banana waterlily, musk grasses, waterweed, and coontail; for the border line between water and marsh or for shallow fresh water, delta potato, wapato, wild millet, frogbit, and thalia; for small openings in marshes or other absolutely quiet waters, duckweeds; for the margin of fresh water where there is no marsh, wild millet; for land dry in summer and overflowed in winter, chufa and wild millet; for bodies of fresh water, almost always full but sometimes drying up in summer, in shallow places wapato and delta potato, and in deeper water, the tuberous white waterlily; and for swamps, swamp privet and water elm.

A recent study of the vegetation of the lakes of the Nebraska sandhill region discloses the important fact that widgeon-grass and sago pondweed withstand alkaline conditions better than any other plants. It is probable that wild celery also will be found to have a degree of endurance of alkalinity.

Some of the new plants listed in Table I are especially desirable, because they are suitable for certain situations besides those inhabited by the plants mentioned in the last two paragraphs. They include six for salt marshes (namely, Nos. 17, 18, 21, 24, 25, and 28), two for salt marshes and sea beaches (39, 40), one for saline lakes (7), two for fresh or brackish marshes (18, 21), one for fresh or brackish water (8), and eight for wet soil (16, 20, and 33 to 38); there are also five for swamps (15, 27, 29, 41, 42) in the number.

WILD RICE.

VALUE AS DUCK FOOD.

Wild rice (*Zizania palustris* and *Z. aquatica*) in every stage of its growth is eaten by one or another of the North American ducks and geese, and practically all of them feed on its ripened grain. It is the staple fall food of many ducks in the numerous rice marshes of eastern United States. The seeds are obtained mainly from the bottom in shallow water, where they have fallen into a bed of soft muck to await germination. Germination is often so delayed that grain may sprout at any time up to at least 18 months after ripening. This accounts for the fact that young shoots and germinating seeds of wild rice are found in ducks' stomachs at practically all seasons. The shoots are devoured by many species, the flowers have been found in the wood duck's stomach, and the stems and leaves of the mature plants are eaten by geese. Wild rice constituted more than 17 per cent of the food of 209 mallards examined, 12 per cent of that of 51 black ducks, and over 11 per cent of that of 75 wood ducks. Other species known to feed upon the plant are the Canada goose, snow goose, pintail, widgeon, lesser and greater scaups or bluebills, canvas-back, redhead, green-winged and blue-winged teals, buffle-head, and ruddy duck.

DESCRIPTION OF PLANT.

Wild rice is a tall, round-stemmed grass with long, flat, pointed leaves (fig. 1). The stem, which may be as much as 2 inches in diameter, is hollow, but is furnished with transverse partitions between as well as at the joints. These partitions may be seen when the stem is cut lengthwise. The base of the stem is in the form of a stout hook, and from it arise the numerous fibrous roots which serve mainly to anchor the plant to the bottom. The flowers of wild rice usually appear during the latter part of July, but may be found as late as November. The appearance of the flower head is very characteristic (fig. 1); the lower branches, which bear the staminate or male flowers, are widely separated and stand out from the stem, while the upper branches of pistillate flowers are erect and more

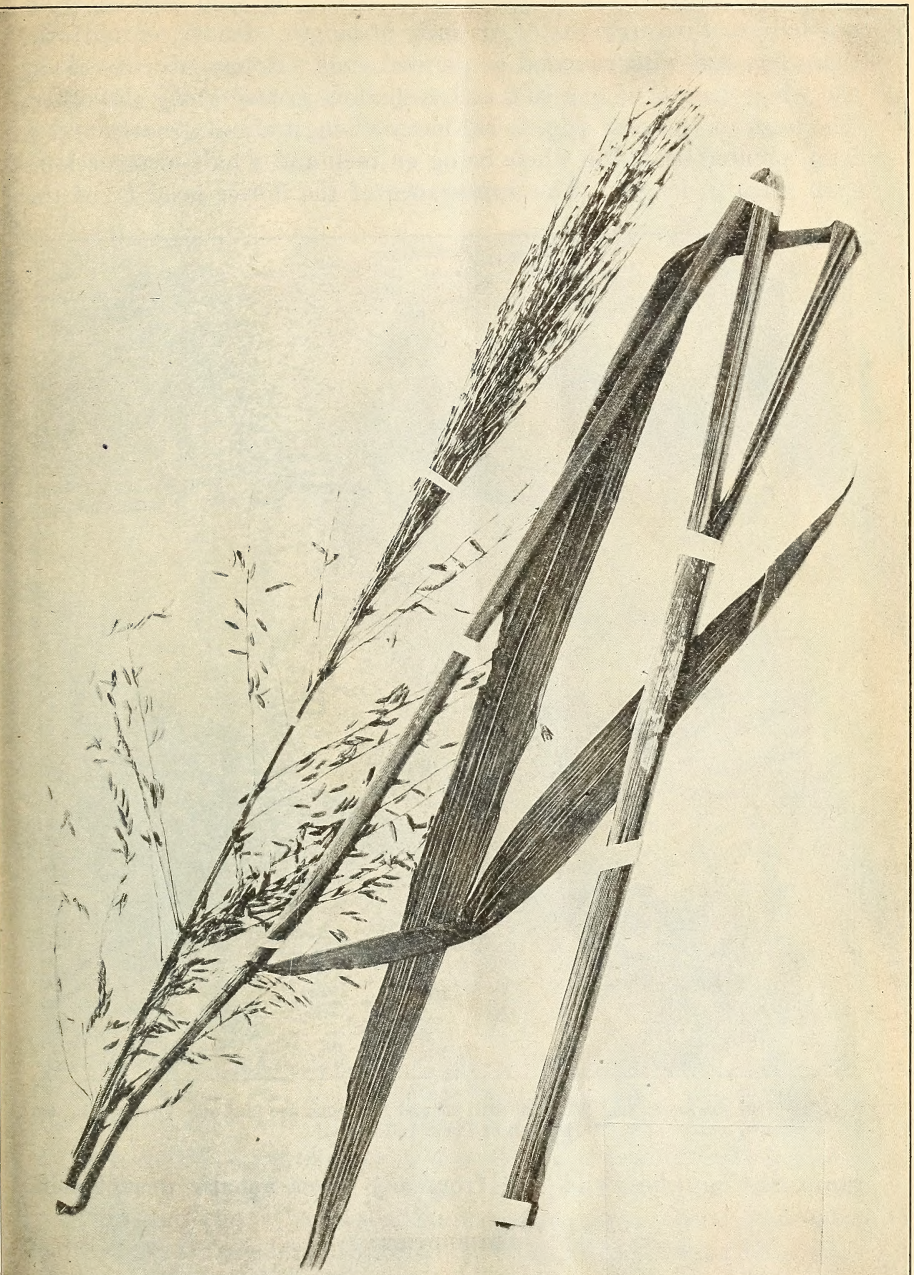

FIG. 1.—Wild rice in flower. (One-half natural size.)

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compactly grouped. The grain (fig. 2, A) of wild rice is from one-half to three-fourths of an inch in length, slender, of uniform diameter, and with rounded or pointed ends. A low rib runs along the whole length of one side and a shallow groove along the other. The husk of the seed (fig. 2, B) has six longitudinal grooves and a long, pointed beak, the whole being an inch and a half or sometimes even more in length. The appearance of the flower head or of the grain distinguishes wild rice from any other aquatic grass in its range.[1]

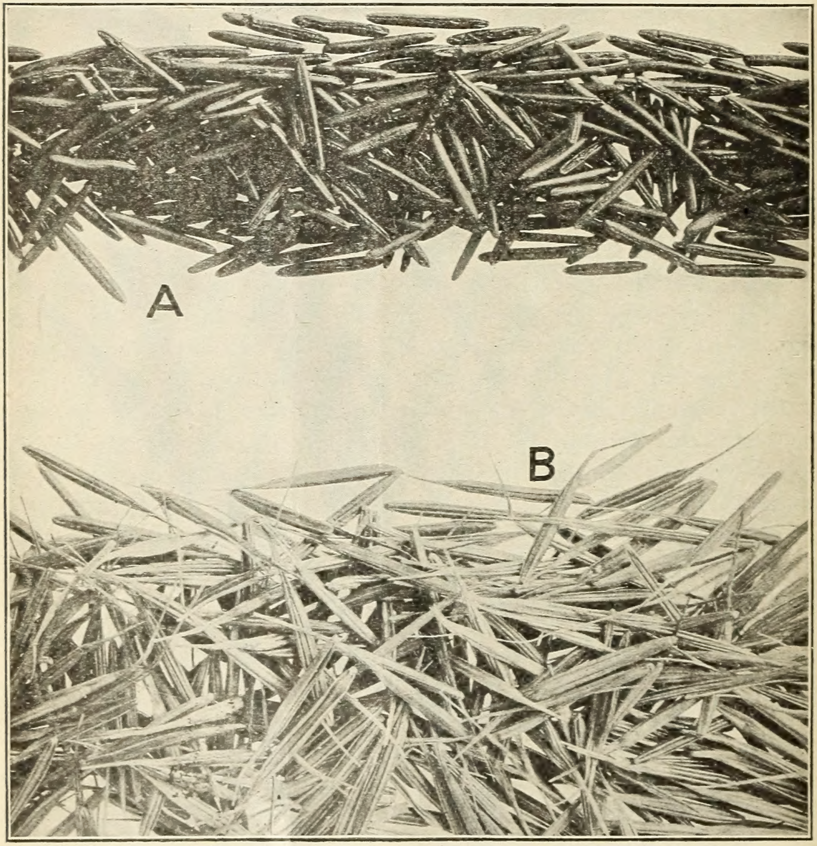

Fig. 2.—Wild rice seed: (A) With the hull off and (B) with the hull on. (From Bull. 50, Bureau of Plant Industry.)

DISTRIBUTION.

Natural growths of wild rice have been found from the northern end of Lake Winnipeg eastward along the northern shores of the

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[1] The southern white marsh or folle avoine (*Zizaniopsis*), superficially much like *Zizania*, does not have the flower head as a whole divided into pistillate and staminate parts, and the grain is ovoid and without a long beak.

Great Lakes and the St. Lawrence River to New Brunswick;[1] from the central Dakotas, western Nebraska, and eastern Texas to the Atlantic coast; and as far south along that coast as central Florida (fig. 3). The plant is rather local and of course is confined to the lowlands. The center of its abundance is in Wisconsin, Iowa, and Minnesota.

PROPAGATION.

Although wild rice does not grow naturally in every suitable place within its range, in most cases it can be made to do so by transplanting. Formerly wild rice was often transplanted by various tribes of Indians, and investigations by the Bureau of Plant Industry have shown that with proper treatment of the seed the plant may be propagated in any favorable waters in the country. It has also been successfully grown in Europe. The black spots on the accompanying map (fig. 3) represent numerous localities where it has been successfully transplanted in North America. The showing thus made should encourage those who are looking for a plant to make barren waters attractive to ducks, and especially those who have already tried wild rice without success. However, experimenters must be prepared for occasional failure, for the plant sometimes refuses to grow

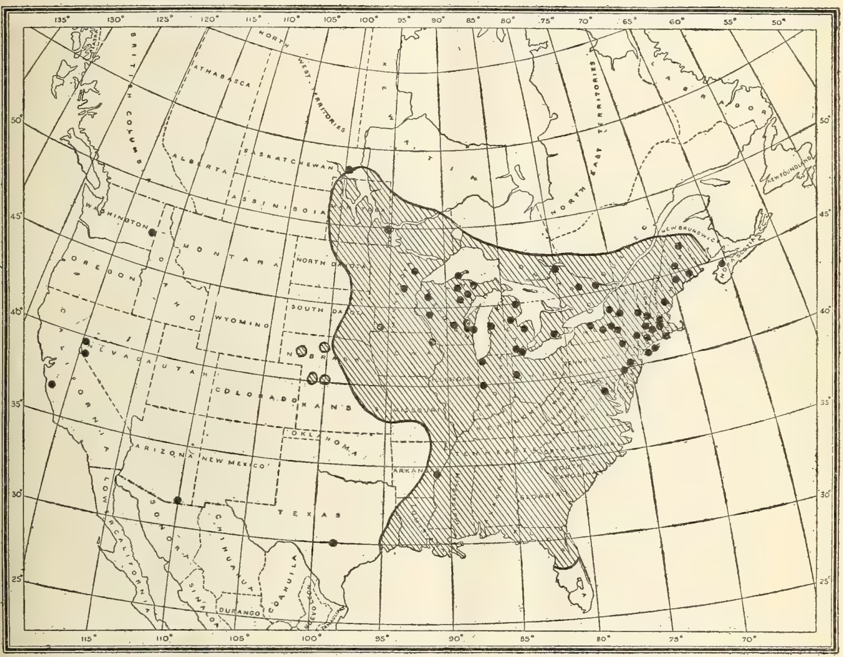

FIG. 3.—Range of wild rice. (Black spots show where it has been successfully transplanted.)

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[1] It is reported without definite locality from Newfoundland.

in localities which appear to possess every requisite for its successful propagation. The usual cause of failure has been improper treatment of the seed between the time of harvesting and sowing, resulting in loss of vitality. When growing naturally, the ripe seeds fall directly into the water, where they sink, and, being provided with barbed beaks, penetrate deeper and deeper into the muck surrounding the roots of the parent plant. There they lie through the winter. They may germinate in spring, or they may lie practically dormant through still another cold season. The seeds therefore remain wet until ready to sprout; they are exposed to currents of water, are not in close contact with each other, and are not subjected to very high temperatures. To succeed with wild rice it is necessary to imitate nature's methods. Keeping large quantities of the seed in close contact often causes fermentation, but this can be prevented by cold storage.

So far as propagation depends on the preservation of the vitality of the seed, the methods so carefully worked out by the Bureau of Plant Industry[1] insure success. Several seed firms handle wild rice properly and will deliver it in either spring or fall as desired. The grain is kept wet and in cold storage, and when shipped is packed in damp moss or fiber.

Sometimes when the stand of wild rice has become reduced it is advisable to prevent consumption by ducks by harvesting the grain and then sowing it after the spring migration. Because the seeds of wild rice ripen and drop off a few at a time, they must be collected every day or so, or the heads must be bunched and tied, so as to prevent the loss of seed. The grain may perhaps be allowed to stand a short time in cold water, if the water is changed daily. But when the whole crop has been gathered it should be placed at once in cold storage, at a temperature just above freezing (from 32° to 34° F.), but still exposed to the air in an open cask or vat.

In cold climates seed may sometimes be perfectly preserved by improvised methods. For instance, wild rice seed kept out of doors and covered with water which was changed daily during the winter, except when frozen, germinated very satisfactorily. It has been stored also in partly filled burlap bags, among which blocks of ice were placed, and the whole covered with sawdust and kept wet. Usually, however, where cold storage is not available it is better to buy seed from a reliable firm.

Where to plant.—Wild rice thrives best on a mud bottom, though it has been known to grow in sand. This may be underlain by various soils, but there should be a layer of mud from at least 2 to 4 inches deep, and preferably deeper. Wild rice usually does not do well where there is much current or change in the level of the water, although it grows abundantly on tide flats. It is not adapted to entirely stagnant water.

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[1] Bull. 50, 1903; Bull. 90, Pt. I, 1905.

It may also be added that the salt-water limits of wild rice may be determined approximately by the simple test of taste. When water is appreciably salty to the taste it is too salty for the successful growth of this plant.[1]

From 4 inches to 6 feet of water are about the limits of its usual occurrence, and it does best in from 1 to 3 feet. In shallow water it may be killed by heat in summer, so it is best, in southern localities especially, to sow the seed in not less than 2 feet of water.

How to plant.—The least possible time must intervene between removal from cold storage and sowing. Broadcast sowing answers every purpose, and the seed should be thickly sown, as, when near together, the growing plants support each other, the root anchorage is protected, and a good stand is more likely to result than if the seed is more widely scattered.

When to plant.—Fall has usually been considered the most desirable time for sowing, but it has been proved that seed sown in spring will bring a full crop, and for several reasons spring sowing is usually advisable. Where seed has been sown in fall, the bottom may freeze and the seed be carried off by the ice in spring. Ducks and other waterfowl, as well as some fishes, eat the seed, and the less it is exposed to their depredations the more abundant will be the crop. Seed is likely also to be buried by depositions of mud, or swept away by currents, especially in freshets. These dangers may be avoided by sowing late enough in spring to avoid the worst spring freshets, but in time to get the benefit of the first good growing weather; that is, when the temperature of the water approaches 60° F.

WILD CELERY.

VALUE AS DUCK FOOD.

The names wild celery (*Vallisneria spiralis*) and canvas-back duck have been closely associated in the annals of American sport. To a certain extent this association is justified, since the canvas-back evidently is very fond of the subterranean propagating buds of this plant. However, the assertion that the flavor of the canvas-back is superior to that of any other duck and that this depends on a diet of wild celery is not proved, to say the least. The scaups, or bluebills, and the redhead also are very fond of wild celery, and are fully as capable of getting the delicious buds as is the canvas-back. Several other ducks get more or less of this food, the writer finding that even the scoters on a Wisconsin lake in fall lived almost exclusively on it for the time. All parts of the plant are eaten by ducks, but the tender winter buds (fig. 8) and rootstocks are relished most. Wild celery buds can usually be obtained only by the diving ducks, as the bluebills, redhead, canvas-back, and scoters. The nondiving species, as the mallard, black duck, baldpate, and the geese, get an occasional bud, but more often they feed upon the leaves. Wild fowl not thus far specifically mentioned which also feed upon wild celery include the wood ducks, pintail, ruddy duck, buffle-head, whistler, green-winged and blue-winged teals, greater and lesser scaups or bluebills, white-winged and surf scoters, and whistling swan.

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[1] Scofield, C. S., Bull. 72, Bureau of Plant Industry, Pt. II, p. 8. 1905.

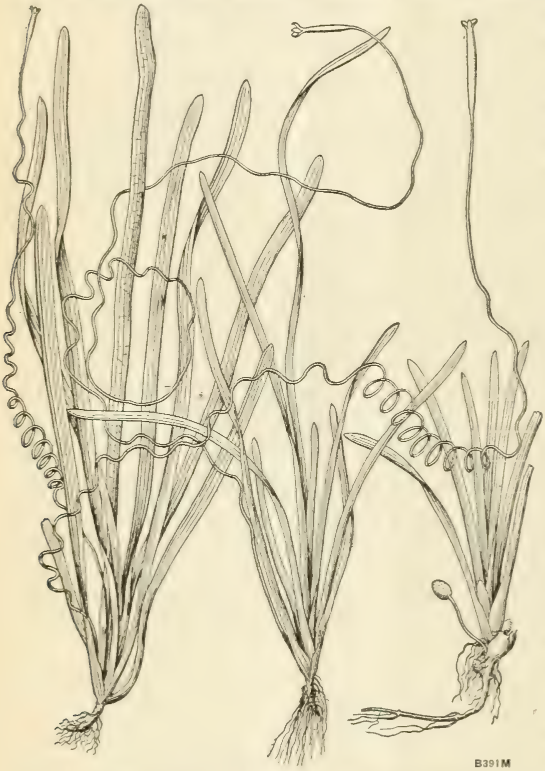


FIG. 4.—Wild celery. (Reduced. From Reichenbach.)

DESCRIPTION OF PLANT.

Wild celery (fig. 4) is a wholly submerged plant with long, flexible, ribbonlike leaves of light translucent green and of practically uniform width (anywhere from one-fourth to three-fourths of an inch) from root to tip. Of course the leaves are narrowed near the tip and may be somewhat serrate or wavy-margined there, but they are never expanded and the venation is peculiar. A leaf held up to the light displays numerous fine straight parallel veins running the whole length. There are, besides, one median and two lateral prominent veins connected at intervals by irregular cross veinlets (see fig. 5). Wild celery may be distinguished from eelgrass (*Zostera marina*), which lives in brackish or salt water, by the fact that its leaves grow in bundles from the rootstocks, while those of eelgrass arise singly and alternate on opposite sides of the stem. The leaves of wild celery generally are more than a fourth of an inch wide, while those of eelgrass are about that width or narrower. Pipewort (*Eriocaulon*), a fresh-water plant, often having ribbonlike leaves, may be recognized by the reticulation of the entire leaf into small cells by veins of nearly uniform size.

In certain stages some of the arrowheads (*Sagittaria*) are difficult to distinguish from wild celery, though they usually have the end of the leaf expanded into a proper leaf blade or else quite pointed, neither of which characteristics is to be found in *Vallisneria.* Investigation of the subterranean organs will decide the matter, however. For a description of those of *Sagittaria* see pages 25–26.

The flowers of wild celery, usually seen in July, are peculiar. The staminate flowers, at first attached at the base of the plants, later float on the surface of the water and fertilize the pistillate flower. The latter is attached to a long, slender, round stem, which contracts into a spiral, drawing the flower under the water after fertilization. This spiral stem, bearing the flower or pod (fig. 4), distinguishes wild celery from the other plants mentioned. The seed pod into which the pollenized flower develops is straight or curved, a little slenderer than a common lead pencil, and from 3 to 6 inches long (fig. 6). It contains, embedded in a clear jelly, small dark seeds, in number about 50 to the inch. No such pod is borne by any other fresh-water plant.

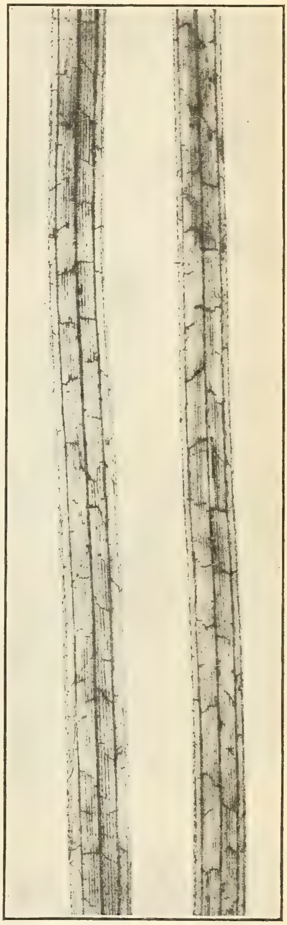


FIG. 5.—Leaves of wild celery, showing venation. (Natural size.)

DISTRIBUTION.

Wild celery occurs naturally from central Minnesota through the Great Lake region to northern Nova Scotia, and from eastern Kansas and eastern Texas east to the Atlantic coast (fig. 7). Like wild rice it is of more or less local distribution, and consequently may be absent from considerable areas within its general range.

PROPAGATION.

Wild celery is comparatively easy to transplant. It can be propagated both by seeds and by winter buds, and the plant itself may be taken up and set out at almost any time. Floating fragments of the plant with a little of the rootstock attached, picked up in midsummer by the writer, have rooted and grown successfully. The prime requisites in propagating celery are the same as in the case of rice; the buds, plants, or seeds must not be allowed to dry or to ferment between gathering and planting. The seed pods (fig. 6) ripen from September to November and fall to the bottom. They are best collected (by net or rake) on days when the water is least ruffled during the latter half of October and early November. The winter buds (fig. 8) may be collected at the same season, before the leaves have disappeared, by following the latter down and digging up the rootstocks and buds; or the young plants may be taken up in spring just as they sprout. They should be kept moist and cool until wanted for planting, as directed for wild rice. If they must be kept for some time they should be put in open vessels of water in cold storage.

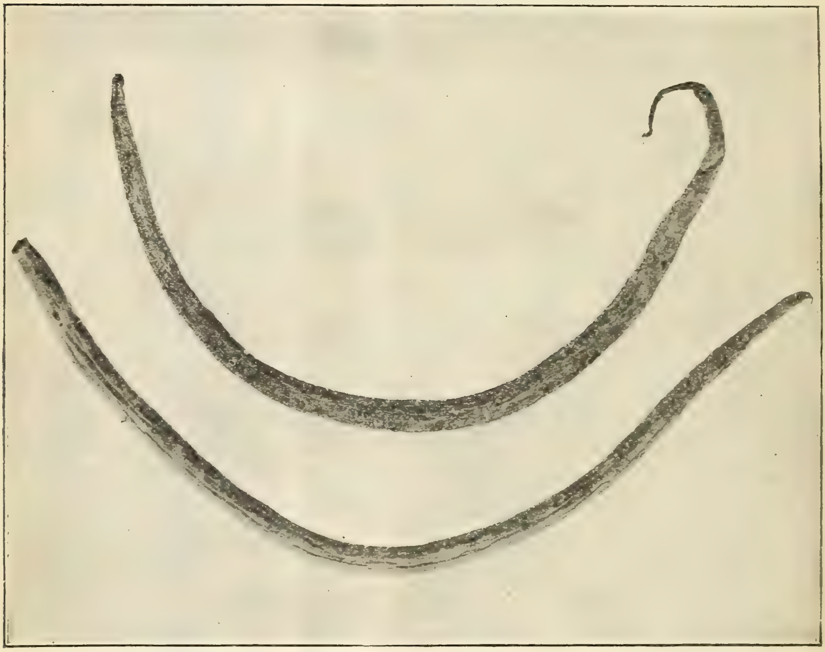


FIG. 6.—Seed pods of wild celery. (Natural size.) B392M

Where to plant.—Wild celery grows best on muddy bottoms in from 3½ to 6½ feet of fresh water, though it will grow also in sand and in both deeper and shallower water. A sluggish current suits it better than either stagnant or rapid water.

How to plant.—For sowing, the pods should be broken up (in water) into pieces about half an inch in length, which may be sown broadcast—not too thickly, as the plant spreads rapidly by rootstocks and will soon make a dense growth. The winter buds or pieces of roots with tufts of leaves must be weighted to hold them to the bottom and enable them to take root. This may be accomplished by loosely threading several plants together and tying stones to them, or by embedding them in balls of clay. The broken seed pods also may be put into clay and dropped.

When to plant.—Where not likely to be covered by mud, the best time to sow the seed pods is in fall. Winter buds collected in fall should be kept in cold storage, and these, as well as young plants gathered in spring, should be set out in May or June.

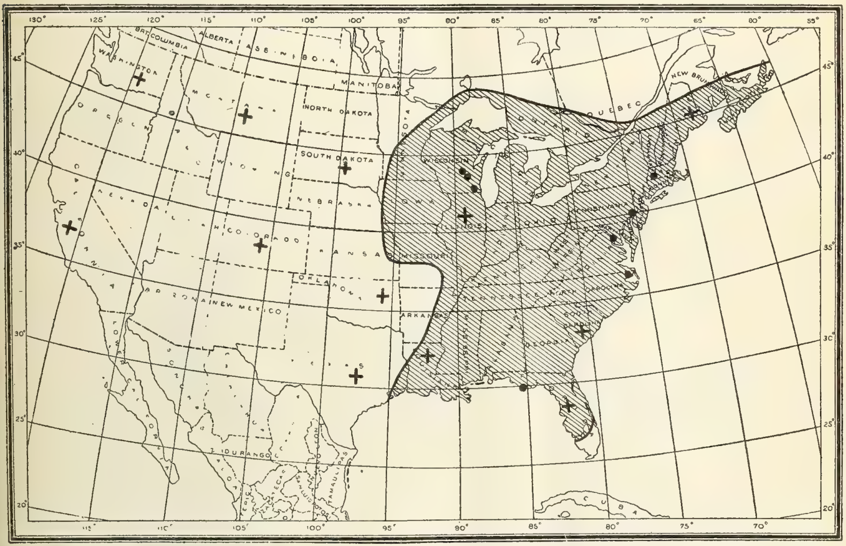


FIG. 7.—Range of wild celery. (Black spots show where it has been successfully transplanted. Crosses indicate States in which it has been propagated, the exact localities being unknown.)

PONDWEEDS.

VALUE AS DUCK FOOD.

Pondweeds (*Potamogeton*) compose a greater percentage of the food of wild ducks than wild rice and wild celery together. This is due to the wider distribution of pondweeds, allowing ducks to feed on them in winter as well as during migration and in the breeding season. There are no fewer than 38 species of pondweeds in the United States, of which at least nine (figs. 9–17) are of practically universal distribution. One of the number, the fennel-leaved or sago pondweed (*P. pectinatus*, fig. 17), produces upon the rootstocks numerous tubers (fig. 18) which are eagerly sought by certain ducks.

This one species makes up five-eighths of the whole quantity of pondweeds eaten by the canvas-back and more than a fourth of the entire food of the bird. Thus it constitutes a slightly greater proportion of the subsistence of the bird than does wild celery. The importance of this plant was pointed out several years ago by Mr. H. L. Skavlem, of Janesville, Wis., who found that at Lake Koshkonong its tubers formed from 60 to 80 per cent of the canvas-back's food.

Besides the tubers on the roots, some pondweeds have winter buds among the leaves, and these, as well as the seeds, rootstocks, and indeed the whole plant, are eaten by ducks. As many as 350 tubers and no fewer than 560 seeds have been found in single stomachs. Pondweeds are really staple food for ducks, and nothing is more common in the stomachs than the seeds of these plants.

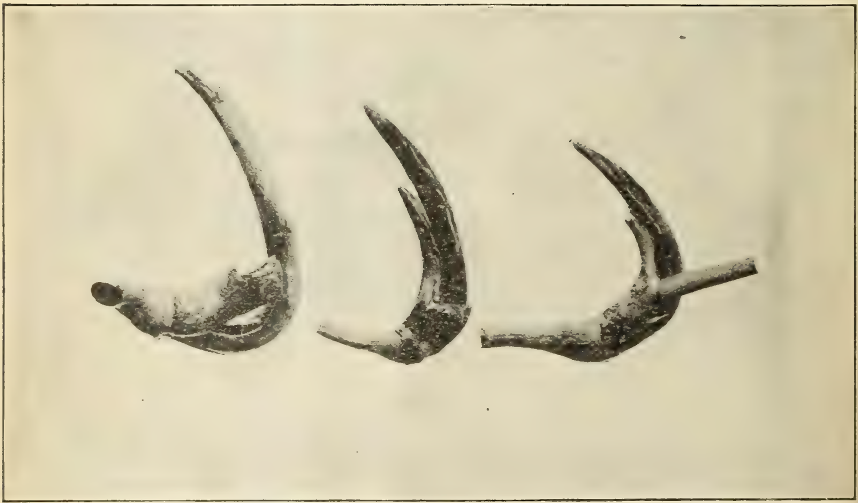


FIG. 8.—Propagating buds of wild celery. (Natural size.)

The many species of pondweeds present a diversity of forms. Illustrations (figs. 9–17) of the nine species of general distribution serve to show the general appearance of some of these plants. All pondweeds are eaten by ducks, and any species would be a valuable acquisition for a ducking ground.

The pondweed illustrated by figure 14 (*P. perfoliatus*) is known as redhead or duck grass, and is an important duck food, said to be especially attractive to redheads. More has been found in the stomachs of canvas-backs than of any other species. All told, 10 species of *Potamogeton* have been identified from duck stomachs, including all but one of the nine most widely ranging forms (figs. 9–17).

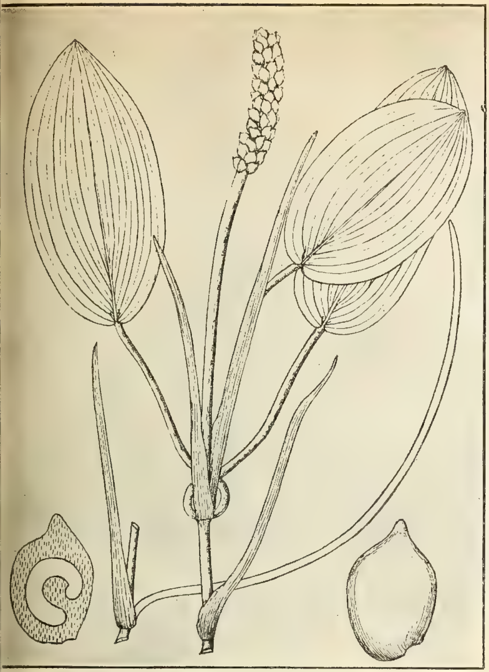


FIG. 9.—*Potamogeton natans.*

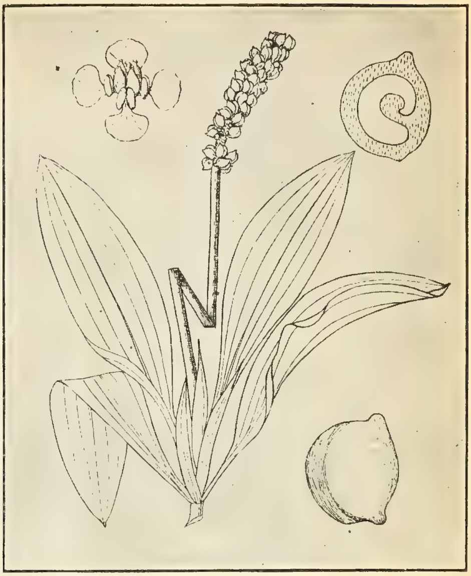


FIG. 10.—*Potamogeton lucens.*

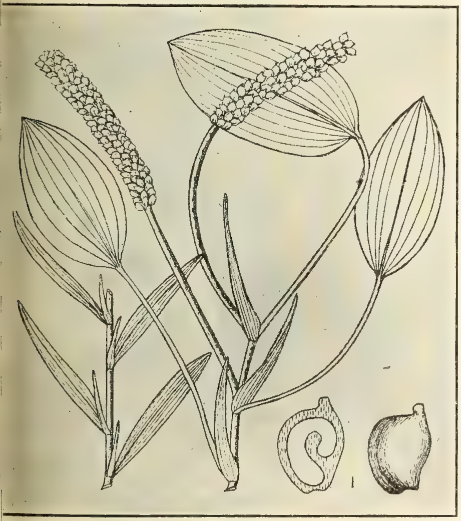


FIG. 11.—*Potamogeton heterophyllus.*

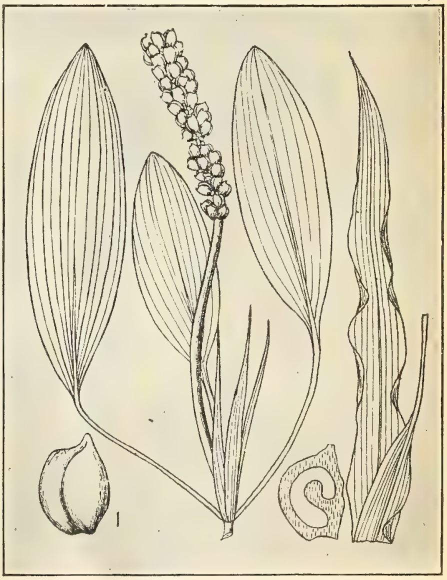


FIG. 12.—*Potamogeton lonchites.*

FIGS. 9–12.—Wide-ranging species of pondweeds. (From Morong.)

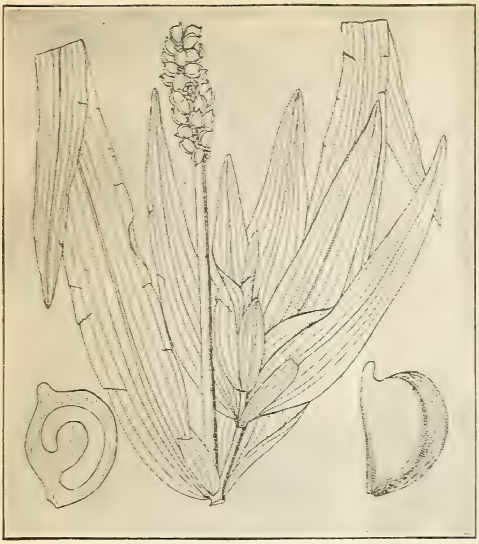


FIG. 13.—*Potamogeton prælongus.* B398M

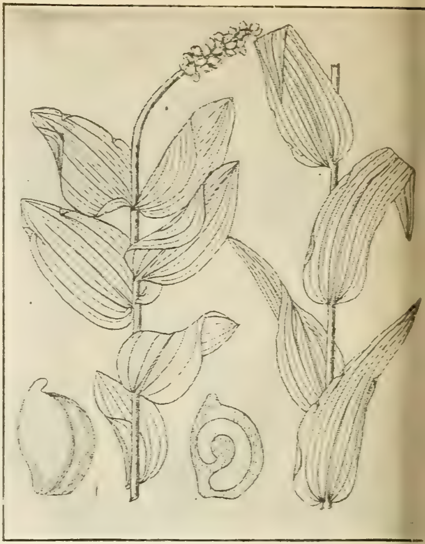


FIG. 14.—*Potamogeton perfoliatus.* B399

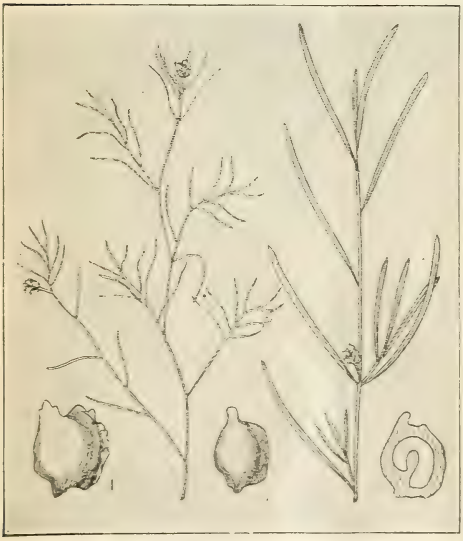


FIG. 15.—*Potamogeton foliosus.* B400M

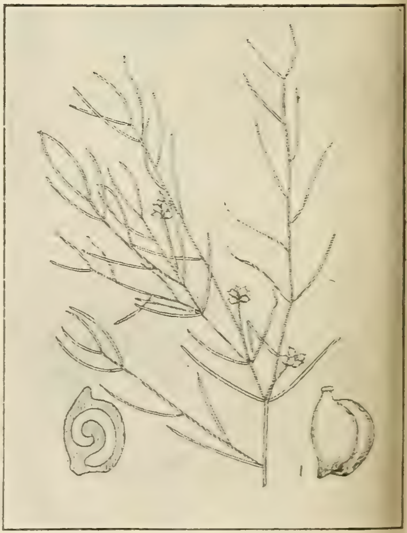


FIG. 16.—*Potamogeton pusillus.* B401M

FIGS. 13–16.—Wide-ranging species of pondweeds. (From Morong.)

The species of ducks and swans thus far found to feed upon pondweeds are the following: Sheldrake, red-breasted merganser, hooded merganser, mallard, black duck, Florida duck, gadwall, European widgeon, American widgeon, green-winged, blue-winged, and cinnamon teal, shoveller, pintail, wood duck, redhead, canvas-back, greater and lesser scaups, ring-necked duck, golden-eye, buffle-head, white-winged and surf scoters, ruddy duck, and whistling swan.

DESCRIPTION OF PLANTS.

The most important species, so far as known, is the sago pondweed (*Potamogeton pectinatus*). This plant has numerous, rather long, threadlike leaves, which present a loose, broomlike appearance in the water. The plant is in some places known as foxtail grass. It is known also as eelgrass, and apparently is the plant termed in Europe poker or pochard grass, after a duck closely related to our redhead. In autumn sago pondweed bears small clusters of light-brown seeds or nutlets near the surface of the water, in form somewhat like loose bunches of grapes. The other pondweeds bear seeds in the same way, and vast numbers of them are eaten by ducks.

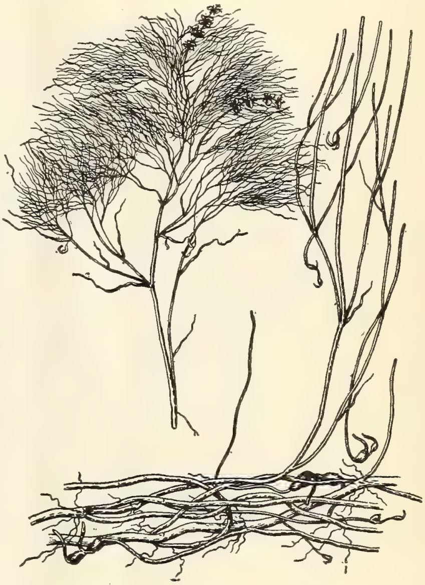


FIG. 17.—Sago pondweed. (Reduced. From Sunset Magazine, February, 1905.)

The general appearance of sago pondweed is well shown by figure 17; note the brush of fine threadlike leaves and the seed clusters as above described. Here also are shown the tender rootstocks with their tubers, delicacies much sought by many ducks. Figure 18 illustrates the tubers natural size.

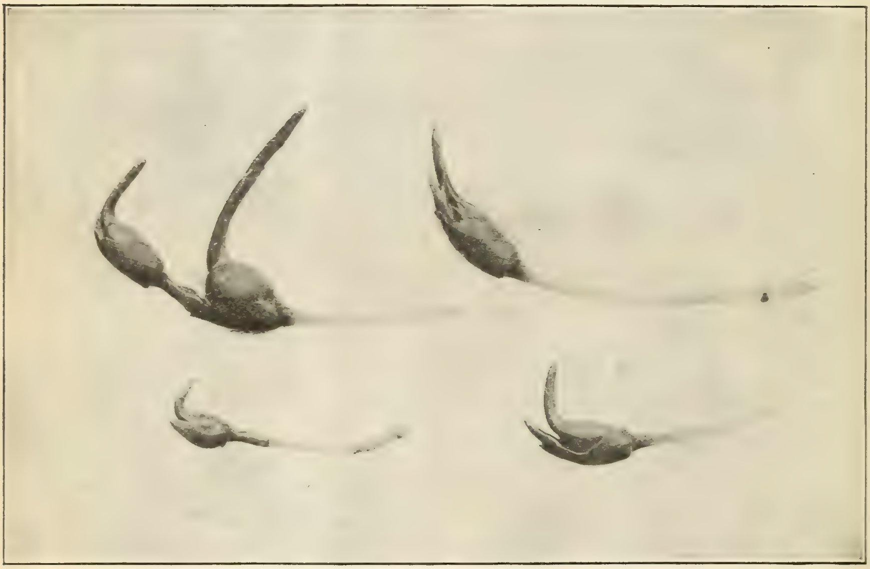
All pondweeds of the *pectinatus* group have tubers, and may therefore be substituted for sago pondweed for propagating purposes. These species are similar in general appearance and hardly distinguishable by the layman. The scientific names and general ranges of the species in the *pectinatus* group are as follows:

Potamogeton filiformis	Northern States, Southern Canada.
Potamogeton interior	Ontario, British Columbia, Colorado, Utah.
Potamogeton latifolius	California, Nevada.
Potamogeton interruptus	Michigan, Saskatchewan, Nebraska.

A pondweed with abundant tuberous rootstocks (*P. heterophyllus*, fig. 11) promises to be of exceptional value, since it changes its form and continues growth when the water surrounding it lowers or dries up. Parts of this plant for propagation are not yet on the market.

DISTRIBUTION.

The range of the sago pondweed is from coast to coast as far south as Florida, Texas, the Mexican plateau, and Lower California, north to Nova Scotia and Hudson Bay, and along the Pacific coast up to latitude 62° north (fig. 19). The distribution of other species has been indicated above.



B403M

FIG. 18.—Tubers of sago pondweed. (Natural size.)

PROPAGATION.

Sago pondweed is easily transplanted by means of the seeds, which are usually gathered with a short section of the top of the plant. Growth from seed may be so delicate as to escape notice the first season, and yet the pond may be filled the second season, for the plant grows much more luxuriantly after the root system becomes well established. Quicker results may be obtained by planting tubers, but these are rather difficult to obtain in quantity. Success has recently been achieved in transplanting young plants of this species, even after shipping them considerable distances.

Stations of the U. S. Bureau of Fisheries use pondweeds to some extent in fish ponds and no difficulty seems to be encountered in transplanting them. Mr. Dwight Lydell, of the Michigan State fish hatchery, states that he has succeeded in propagating *Potamogeton* by means of seeds and of whole plants. He further states that the most successful and largest growths have been on bottoms where the mud is about 6 inches deep over sand or clay. By mowing the plants in lakes where they are plentiful and scattering them about the ponds, no trouble has been experienced in getting a good crop.

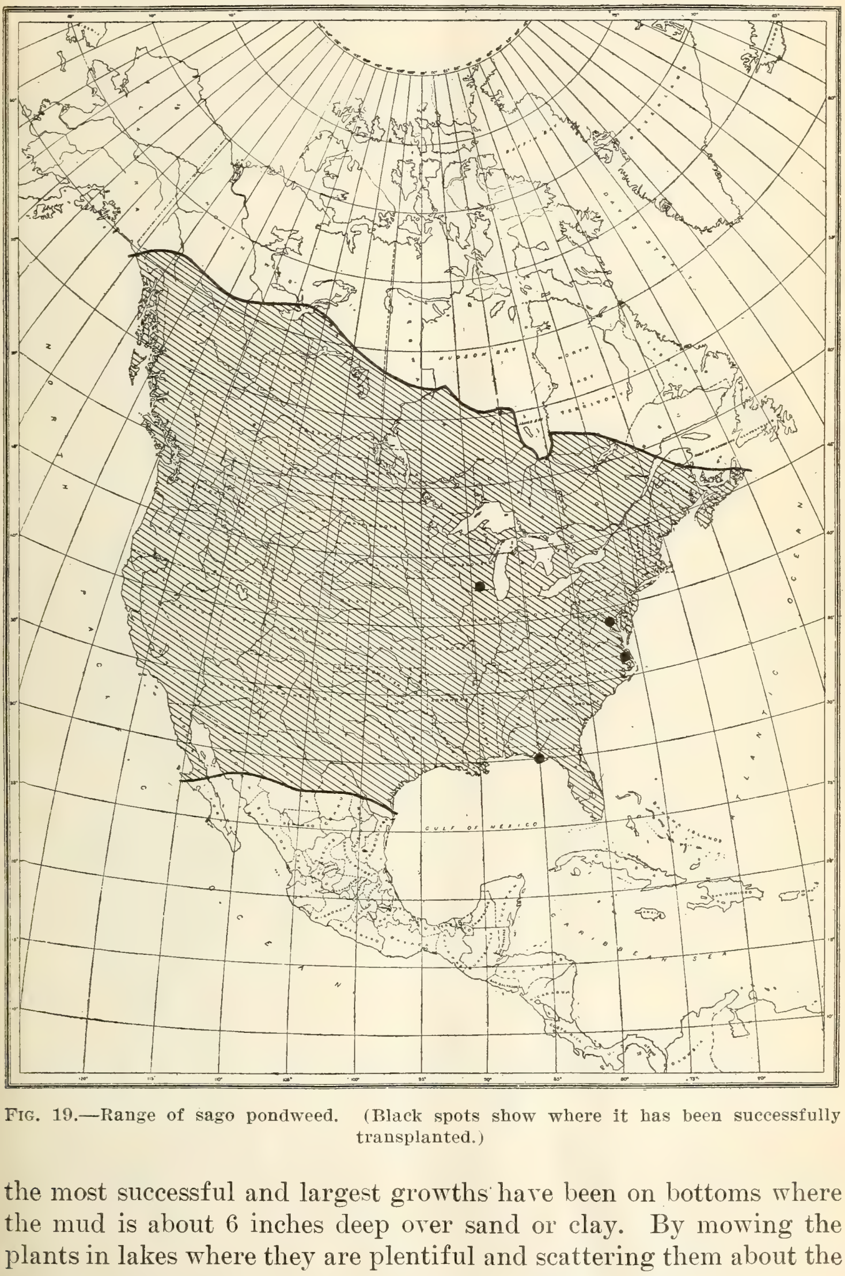


FIG. 19.—Range of sago pondweed. (Black spots show where it has been successfully transplanted.)

How to plant.—Pondweeds may be transplanted on a large scale by mowing[1] the whole plants with the seeds attached and scattering about where growth is desired. The seeds alone may be collected and sown broadcast, or they may be embedded in clay balls and distributed over the bottom.

Where to plant.—Most pondweeds require fresh water, but a few species, including the sago pondweed and its relatives listed on page 17, will grow in brackish or salt water. Mud bottom is preferable, but both sago pondweed and redhead grass will grow on sand. The water in which pondweeds are planted should be from 2 to 6 feet deep.

When to plant.—The seeds may be planted immediately after gathering, or if cold storage is available they may be held until spring, as described in the case of wild rice.

Seeds of the various species ripen at different times, but in the North they may be looked for after August. Those of sago pondweed are in best condition in September and October.

ENEMIES OF WILD RICE, WILD CELERY, AND PONDWEEDS.

The three genera of plants thus far discussed—wild rice (*Zizania*), wild celery (*Vallisneria*), and pondweeds (*Potamogeton*)—vary greatly in abundance. The causes of this diversity are not well understood, but the plants have enemies whose habits are known and whose attacks may to some extent be warded off. Wild rice is generally eaten by moose, deer, and cattle, but where the damage warrants the necessary expenditure these animals can be fenced out. Muskrats tear up and eat these plants, but, so far as known, not to a serious extent. Carp also feed on them, and—

> the evidence seems to be pretty strong that in general they are very destructive, and are probably in large part at least responsible for the great destruction of wild celery and wild rice that has been noted in many of our inland marshes in the last few years. This, in turn, has deprived certain ducks, especially the canvas-back and redhead, of an important food supply, and has undoubtedly influenced their abundance to some extent in the localities in question.[2]

In waters controlled exclusively by one interest, carp may be extirpated by partial or complete drainage and by the netting of the fish, together with the construction of wire screens or other barriers across all inlets and outlets. Where this is not practicable, systematic poisoning with fish berries or copper sulphate may succeed, but only at the expense of many forms of life besides the carp, and in the long run it might be more injurious to the duck food than to the carp. However, these methods are applicable only in small bodies of water; elsewhere effective measures against carp are impracticable

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[1] A description of the machine for mowing aquatic plants may be found in the Report of the U. S. Fish Comm., 1892, pp. 477–478.

[2] Cole, Leon J., Appendix Rept. Comm. Fisheries, for 1904, p. 592, 1905.

THE ARROWHEADS.

Several of the 27 species of *Sagittaria* found in the United States have leaves shaped like the points of Indian arrows, a fact that has given the group the common name of arrowheads. A number of the species, however, never have arrow-shaped leaves, the leaves being oval, lanceolate, or even without a blade in the ordinary sense of the word. Species of both groups are tuber-bearing, however, and therefore important as food for wild ducks. The species which are valuable on this account include those listed on page 2, which are not at present on the market, and the delta potato and wapato, here treated in detail.

DELTA POTATO.

VALUE AS DUCK FOOD.

In the latter part of January and early February, 1910, the writer, under authorization of the Biological Survey, visited the Mississippi Delta, La., chiefly to find out what attracts large numbers of canvas-backs to this shoal-water region, the shallow ponds and lakes of which are so different from the comparatively deep-water bodies frequented by canvas-backs in the Northern States. The attraction was found to be a tuberous species (*Sagittaria platyphylla*), known to the hunters of this and other parts of Louisiana as wild potato or wild onion. From an examination of a large number of stomachs it was found that about 70 per cent of the food of the canvas-backs collected consisted of the tubers of this plant, as did also more than 65 per cent of the food of the mallards. The pintail also fed upon the tubers. The gullet of one canvas-back was filled to the throat with the delta potatoes, 24 entire ones being present, besides ground-up remains of several others. Other individuals had 14 to 17 of the tubers in their gullets. There is no doubt that *S. platyphylla* is an important food for the larger species of ducks, not only in the Mississippi Delta, but throughout the whole range of the plant.

DESCRIPTION OF PLANT.

The delta potato (fig. 20), when well developed, stands about 18 inches above the soil. The broadly elliptical leaves have a characteristic firm appearance and a beautiful clear green color. Like all plants of its genus, this species produces flowering peduncles from about the center of the group of leafstalks; these peduncles bear flowers in whorls of three, and the individual flowers each have three white petals and a yellow center. The petals soon fall and the small green balls of immature seeds remain. These enlarge during the summer, and when ripe are brown and nearly half an inch in diameter. They are easily crushed, separating into hundreds of thin triangular seeds.

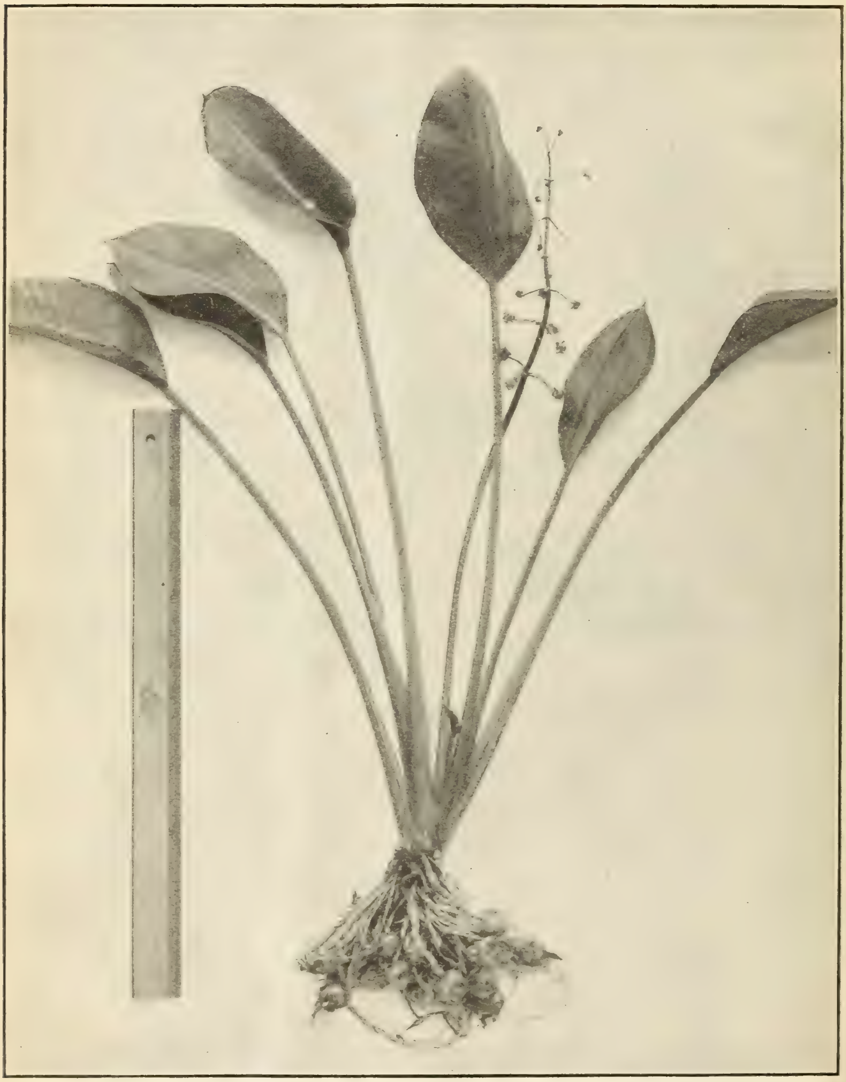

FIG. 20.—Delta potato. (Scale is 18 inches long.) B355M

The tubers are of irregular globular shape and vary up to an inch in diameter. They are formed at the ends of runners (thicker than the fibrous roots) and bear on the side opposite the attachment to the runner a scale-sheathed bud which may be an inch or more in length.

Running around the body of the tuber are two or three darker lines from which originate fibrous sheaths. A glance at the illustration of the tubers (fig. 21) of this species shows the aptness of the name "wild potato." It should be explained, however, that normally the tubers are more widely separated than is the case with those on this particular specimen, which was grown in a flower-pot.

DISTRIBUTION.

In ancient times the Mississippi River emptied into a vast bay which extended at least as far north as the region now known as southern Illinois. Its actively growing delta (which is still apparently in full vigor) made thick deposits of silt over some thousands of square miles of this area while the remainder was being slowly elevated. *Sagittaria platyphylla* is so nearly confined in its distribution to this ancient basin, and is so characteristic of the present delta, that the name delta potato is eminently fitting. The outlying points of the range of the plant as now known are San Antonio, Tex., Lake City, Mo., Chattanooga, Tenn., and Mobile, Ala. (fig. 22).

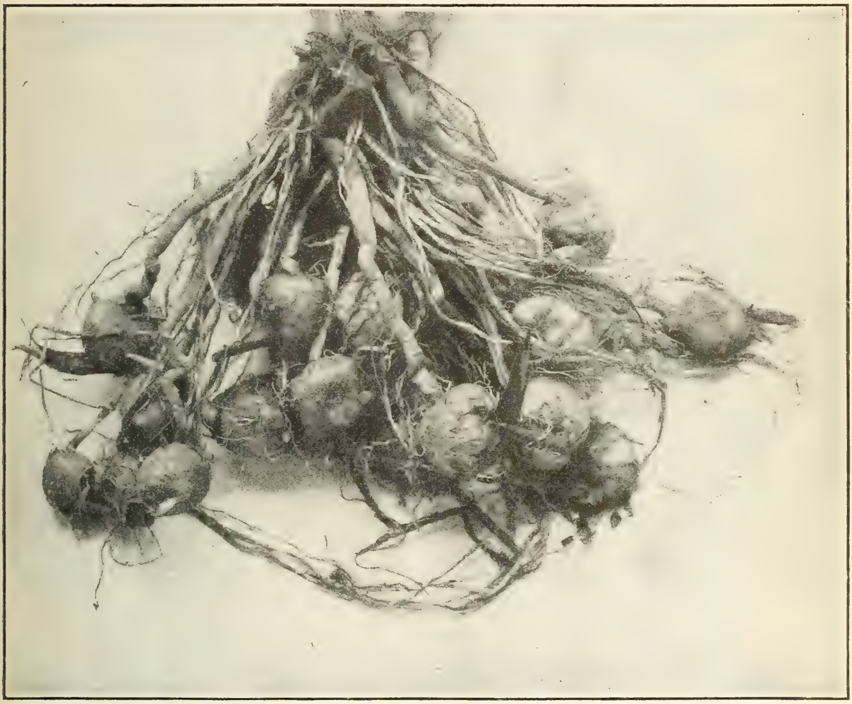
B355AM

FIG. 21.—Tubers of delta potato. (About two-thirds natural size.)

PROPAGATION.

The delta potato undoubtedly can be propagated from seed, but, all things considered, transplanting the tubers is probably much the better method. This insures a large percentage of success, the plants will be larger, and as they will produce other tubers the first year they are much more valuable. Extraordinary precautions to prevent drying are not necessary, but the tubers should be kept cool and well exposed to the air to prevent heating or fermentation.

To plant, embed the tubers in mud bottom where the water is not more than a foot deep, preferably not more than 6 inches. It is better to err on the shallow side. The plant will grow thriftily on soil never covered by water but which has plenty of moisture. In such situations, however, the tubers are not available to ducks unless overflowed in winter. The delta potato is not injured by a slight quantity of salt in the soil. The plant is probably hardy anywhere in the southern half of the United States and may prove to be so farther north.

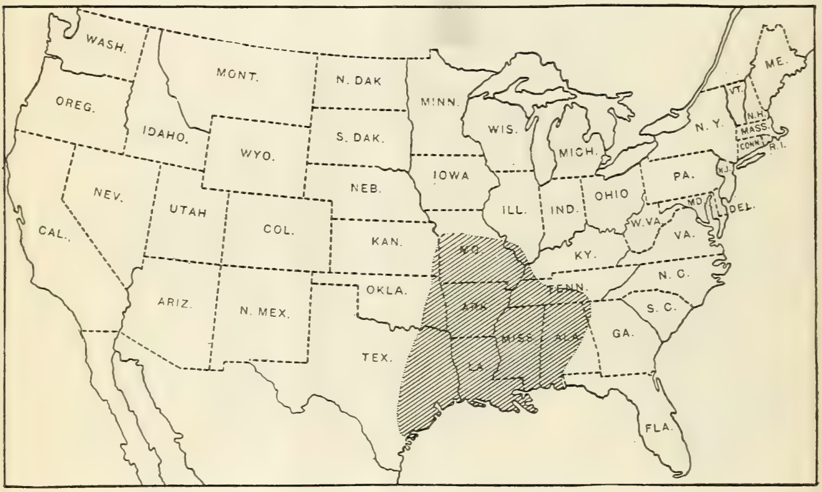

FIG. 22.—Range of delta potato.

WAPATO.

VALUE AS DUCK FOOD.

The tubers of the wapato (*Sagittaria latifolia* and *S. arifolia*) have been known to white men as an important food for wild fowl since the time of the Lewis and Clark expedition of 1804–6. These famous explorers state that in the Columbia River valley large numbers of ducks, geese, and swans occur where this plant is abundant and that the swans in particular feed extensively upon the plant. A correspondent of the Biological Survey, Mr. George W. Russell, of Gaston, Oreg., writes that the wapato is fed upon most by the diving ducks, as the canvas-back, redhead, and bluebills (scaups), and that they seek it whenever they are present in the country where it grows. Prof. David Dale Owen, in his report of a geological survey of Wisconsin, Iowa, and Minnesota, notes that these tubers afford much nourishment to the larger aquatic fowls. The vernacular names swan potato and duck potato that have been applied to these plants give further evidence of their value to wild fowl. Other local names are swamp potato, muskrat potato, Chinese onion, and water nut. The Biological Survey has found various parts of *Sagittaria* plants in stomachs of the following species of waterfowl: Mallard, widgeon, green-winged teal, blue-winged teal, spoonbill, pintail, canvas-back, little bluebill, ruddy duck, Canada goose, and whooping swan.

DESCRIPTION OF PLANT.

The general relations of stems, flowers, and tubers are the same in the wapato (fig. 23) as in the delta potato, but the shape of the leaves is entirely different. Both *Sagittaria latifolia* and *S. arifolia* have arrowhead-shaped leaves. These vary greatly in the length, width, and shape of the point and barbs and in the degree of divergence of the latter. Various forms of leaves are illustrated in figure 24. The wapato plant sometimes reaches a height of 4 feet. The appearance of the flowers and seed balls is much the same as in the delta potato.

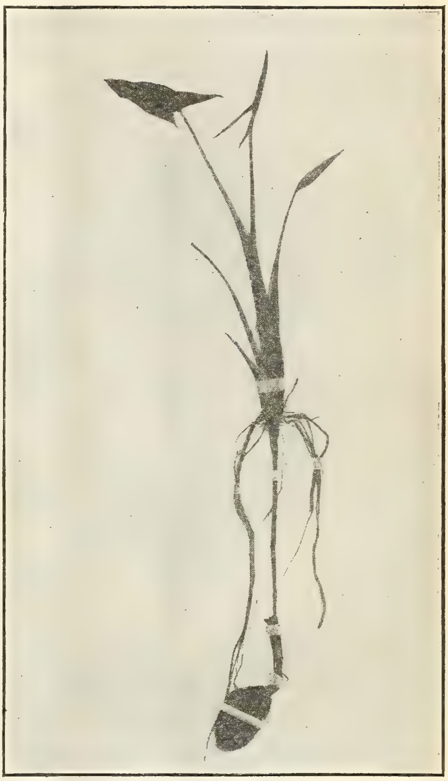

FIG. 23.—Young eastern plant of wapato with single tuber. (Two thirds natural size.)

The tubers of *S. latifolia* (fig. 25), from six to nine to the plant, are formed on runners in the same manner as those of the delta potato, but they attain a much larger size. The largest specimen examined by the writer was 2 inches in its longest diameter and 1 inch thick. Including the bud and a short stalk at the base, the entire tuber may measure as much as 5 inches in length. The mature tubers of plants from the Northwest are more or less flattened, the shape being comparable to that of the ordinary edible crab. The smaller tubers are more nearly spherical (varying to ovoid), and this is the shape of even the largest tubers of eastern plants that the writer has seen. The sheaths of the tuber, being of a darker color than the body, are conspicuous.

DISTRIBUTION.

Sagittaria latifolia is found from the Atlantic coast to the Pacific, its range covering practically the whole United States (fig. 26). Areas from which it apparently has not been reported are peninsular Florida, the southern two-thirds of Louisiana and Texas, New Mexico, Arizona, and southern California. The northern limit of its range is marked by the following localities: Vancouver Island, Saskatchewan River, and southern Ontario and Quebec. *Sagittaria arifolia* is confined to States from Michigan and Kansas westward. Its range is largely included in that of *S. latifolia*, although it has been collected in New Mexico. The two species are distinguishable with certainty only upon the basis of mature seeds, and for all practical purposes may be considered as one.

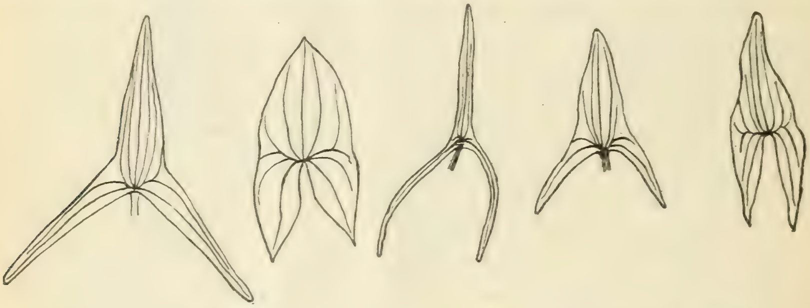

FIG. 24.—Various shapes of wapato leaves. (About one-tenth natural size.)

PROPAGATION.

The wapato may be transplanted by means of both seeds and tubers,[1] but the latter are the most reliable and give the quickest results. They may be set with the bud just beneath the surface in mud bottom under a foot of water or preferably less. The plants will grow in wet soil, but the tubers are not available for duck food in such places unless overflowed in fall and winter.

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[1] It is probable that tubers of *Sagittaria chinensis*, which are in market wherever there is a large Chinese colony, and which are also on sale by seedsmen, may be substituted for those of wapato with satisfactory results.

The tubers of this plant are known to retain their vitality when dried, but more uniform success will probably result if drying is not carried to an extreme. Tubers should be shipped promptly after gathering, in well-ventilated packages, and should be planted immediately upon receipt. The wapato is suitable for cultivation in practically all parts of the United States.

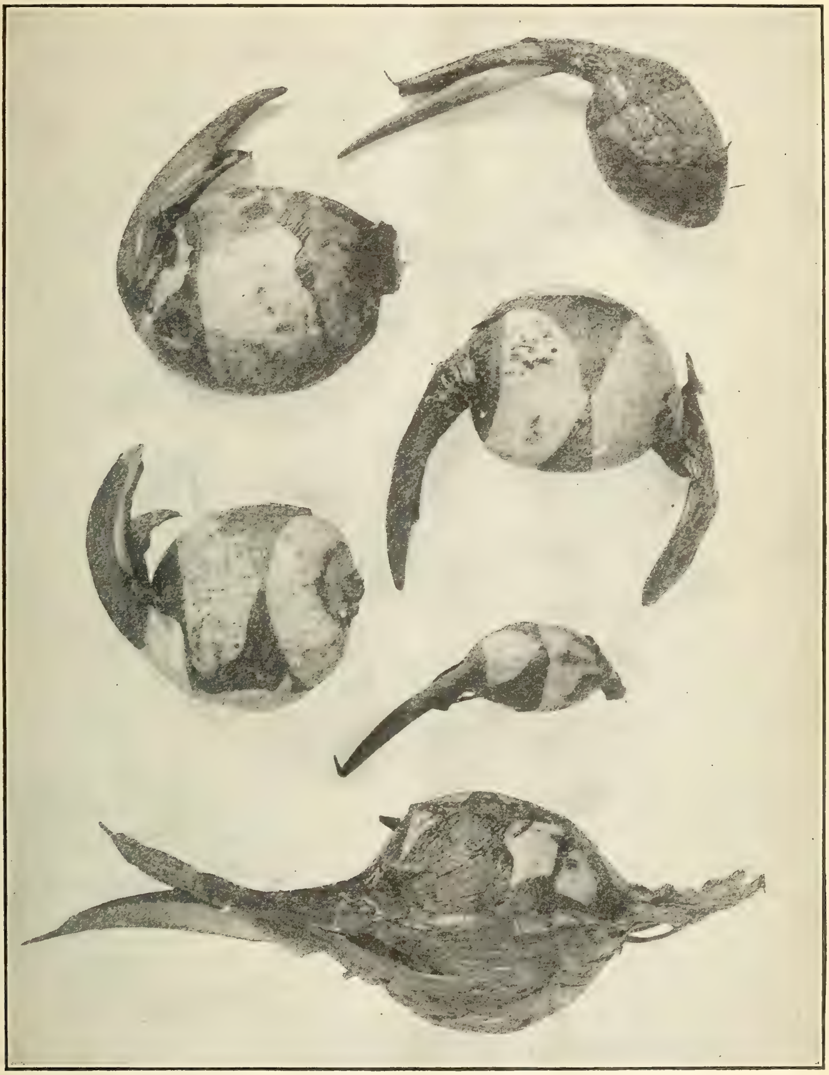

FIG. 25.—Wapato tubers. (About two-thirds natural size.)

CHUFA.

VALUE AS DUCK FOOD.

Like some of the other duck foods mentioned in this bulletin, chufas (*Cyperus esculentus*) are at present known to be of only local importance. Those best acquainted with conditions at Big Lake, Ark., formerly one of the most famous hunting grounds of the South, now a national bird-reservation, believe that the chufa, or nut grass as it is there called, is the principal element in rendering that lake so attractive to waterfowl. Examination of stomachs from that locality seems to justify this belief. Six of a series of nine mallards collected at Big Lake in December, 1910, had fed on sedge tubers, the average percentage of which in the food of the nine was 56. Tubers of this species, or others of its genus, have been found also in duck stomachs from Florida, Illinois, Minnesota, and California. The species of ducks now known to feed on chufas are the wood duck, mottled duck, mallard, and canvas-back.

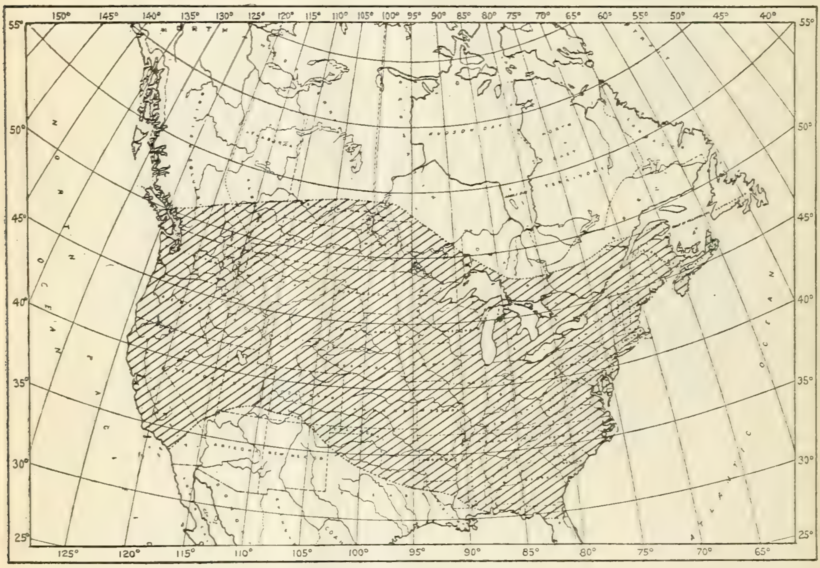

FIG. 26.—Range of the wapato.

DESCRIPTION OF PLANT.

The chufa (fig. 27) belongs to the group of plants known as sedges. These are grasslike and are usually classed with grasses by nonbotanists. Many of the sedges, however, including the chufa, have triangular, not round, stalks. The members of the genus *Cyperus* have a group of leaves at the base from which rises the stalk bearing the flowers and seeds. In the chufa these stalks are from 1 to 3 feet high. Several flower clusters on peduncles of varying length rise from the top of the stalk. From the same point three rather long, grasslike leaves project below the fruiting clusters.

Many members of the genus have a very similar appearance, and it is not likely that nonbotanical observers will distinguish them.

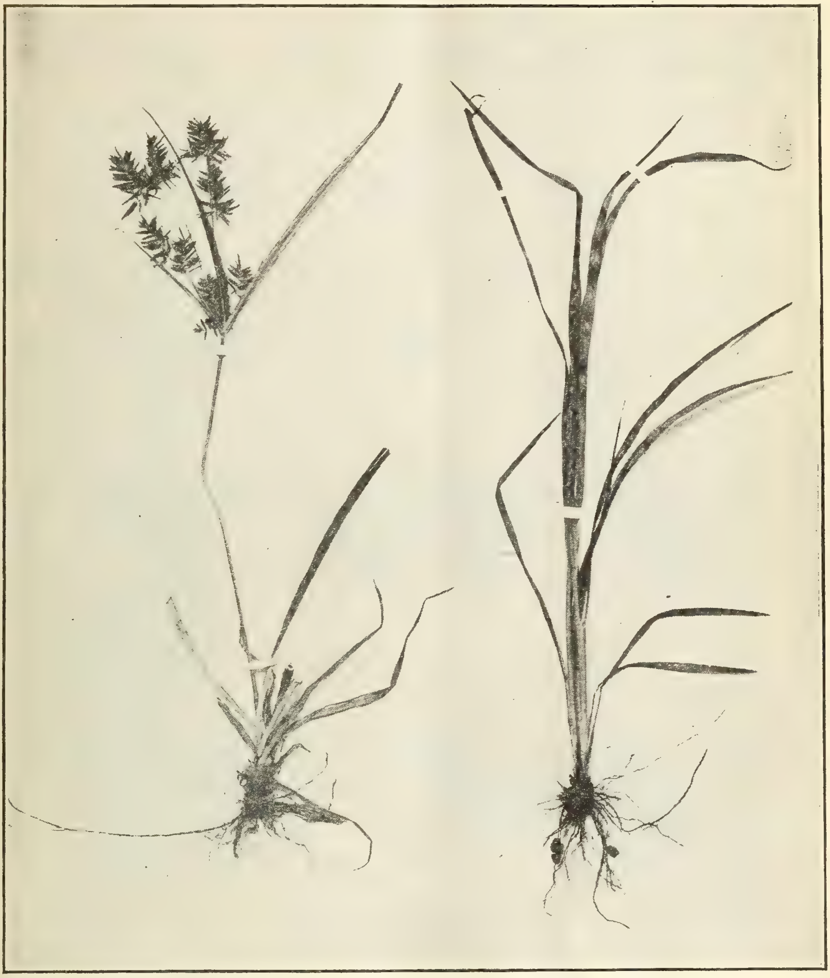

Fig. 27 —Seed-bearing and immature plants of chufa. (Much reduced.)

This is unnecessary, however, as tubers of the chufa may be obtained for propagation from most seedsmen. The tubers are formed at the ends of scale-covered rootstocks. The plant is extremely prolific, cultivated forms usually producing 100 tubers to the plant, and instances are known in which more than 600 tubers were produced in one season from one tuber planted in spring.

Well-developed tubers of the cultivated variety average about three-fourths of an inch in length by three-eighths of an inch in diameter when dried. Tubers from wild plants are usually much smaller and have a greater proportion of fiber. The general appearance of chufas and of tubers from a wild sedge is well shown in figure 28.

Chufas are known also by the vernacular names earth almonds and ground nuts, and the plant as nut grass and cache-cache.

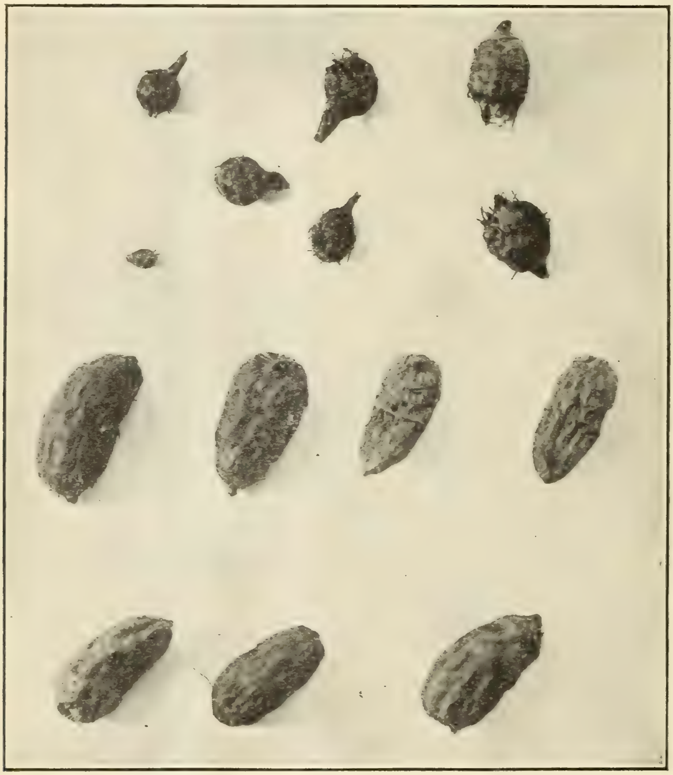

FIG. 28.—Tubers of wild and cultivated chufas. (Natural size.)

DISTRIBUTION.

The northern boundary of the natural range of the chufa is marked by the following localities: Southern New Brunswick, southern Ontario, northern Nebraska, New Mexico, Arizona, and the Columbia River valley. The plant seems to be absent from most of the Great Basin and Rocky Mountain regions. From its northern limit the plant ranges southward over the remainder of the continent. (See fig. 29.) It is widely distributed in warm climates over the entire world.

PROPAGATION.

Although the chufa seems not to grow naturally in a large area in western United States, there is no doubt that it can be cultivated everywhere except in the higher parts of the Rocky Mountain region. It is said to do fairly well at the altitude of Denver.

Chufas can be obtained from most seedsmen and are so cheap that it will pay sportsmen to buy new stock every few years, if earlier plantings show degeneration in size of tubers and hence reduction in value as duck food. Chufas do best on light or somewhat sandy but rich soils. They are available for duck food only when planted on land dry in summer and overflowed in winter. In the open they should be planted thickly so as to give the plants a better chance in competition with weeds. In timbered land they need not be planted so thickly, but they will do well in only rather sparse growths, where considerable light penetrates to the ground. When possible the land intended for planting should be broken up and freed from weeds. The tubers should be planted just beneath the surface in spring.

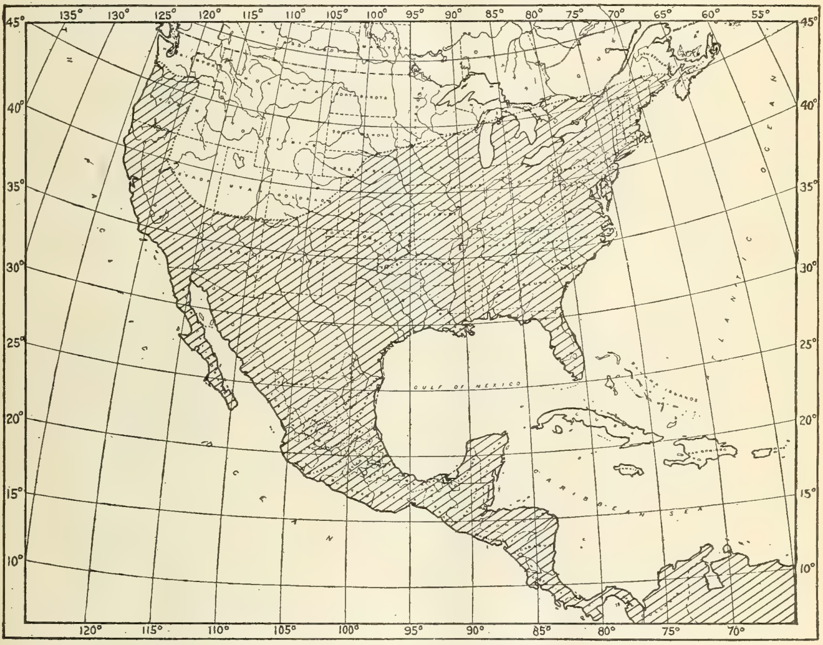

FIG. 29.—Range of the chufa.

WILD MILLET.

VALUE AS DUCK FOOD.

Wild millet (*Echinochloa crus-galli*) is an important food for ducks in widely separated regions of the United States. At Mud Lake, Ark., the writer found seeds of this plant to constitute more than 10 per cent of the food of 41 mallards collected; at Belle Isle, La., it made up more than half the food of the few mallards examined; and at Cameron, La., over 75 per cent of the diet of a collection of 50 ducks of the same species. Pintails, teal, and other shoal-water ducks are almost equally fond of it. Geese eat the stems and leaves of the plant, as do also ducks when they are hard pressed. Testimony as to the value of the plant as a wild-duck food has come from Wisconsin and Oregon, and the Biological Survey has found seeds of wild millet in duck stomachs from Massachusetts, South Dakota, Missouri, and Nebraska in addition to the States mentioned.

The plant is popularly known throughout lower Louisiana as wild rice and is given about the same rank as a duck food as the plant (*Zizania aquatica*) known by that name in the North. Other popular names referring to the preference of wild fowl for the plant are goose grass and blue-duck food.

DESCRIPTION OF PLANT.

Wild millet is a coarse, leafy grass which grows from 1 to 6 feet in height. The stems and foliage are not especially remarkable, but the fruiting head has characters which enable one easily to distinguish this from other species of native grasses. The chaff or outer seed covering is set with rows of short, stiff, outstanding spines. These project beyond the general outline of the body of the seeds and give them an easily visible spiny appearance (fig. 30). The inner scale of the chaff terminates in a spine which is always stouter and longer than the others. This spine or awn may be very short, or it may be from 2 to 3 inches or more in length, surpassing by many times the length of the seed. One of the other scales also may bear a long spine at the tip. The prickly character of the seed coverings is referred to in the name cockspur grass. The longer awns in particular, and sometimes the whole fruiting heads, may have a deep purplish color. This, no doubt, suggested the name blue-duck food used in the Mississippi Delta. The long-awned form has been given the varietal name *longearistata* but for present purposes we may consider all the types illustrated in figures 30 and 31 under the same name. It is probable also that the form named *Echinochloa walteri* is fully connected with *E. crus-galli* by intergrades and deserves only varietal rank. This form has the lower or all-leaf sheaths rough hispid.

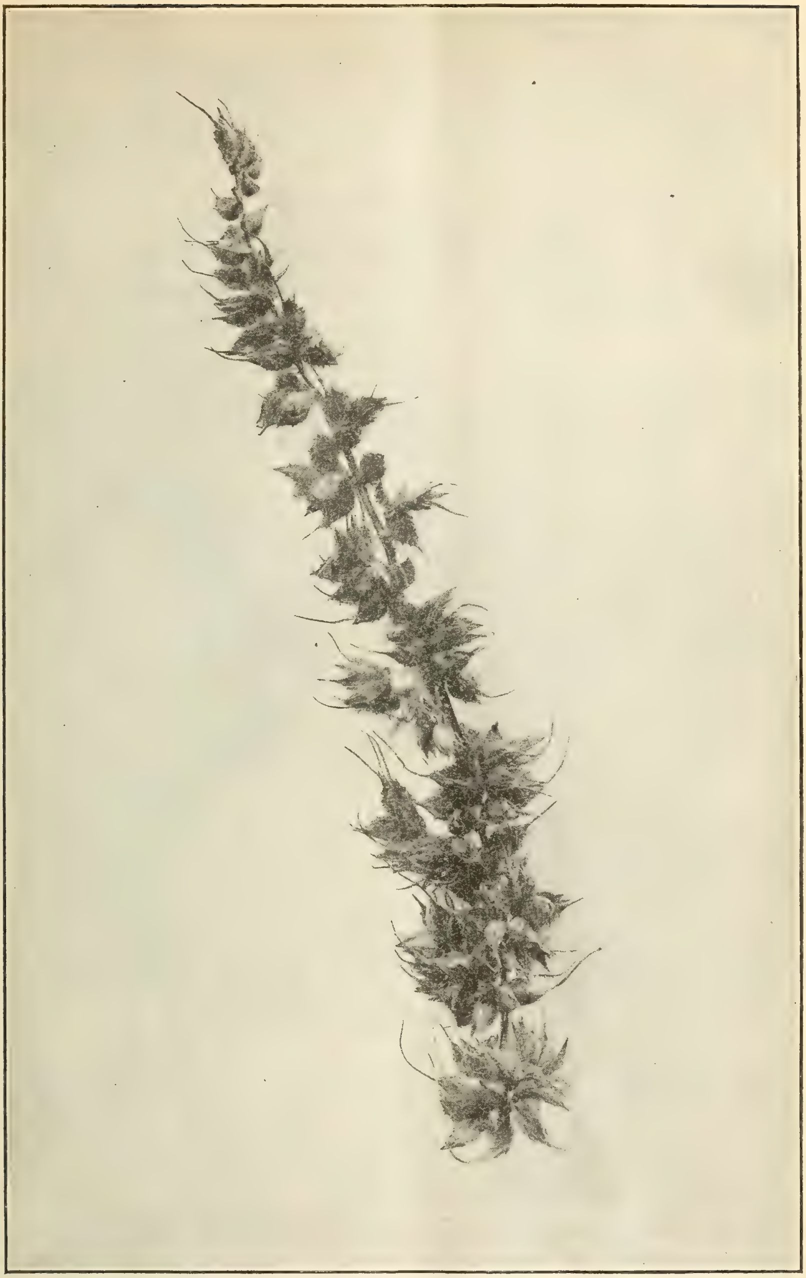

FIG. 30.—Part of fruiting head of wild millet. (Natural size.)

DISTRIBUTION.

The northern limit of the range of wild millet so far as known does not much surpass the latitude of the northern boundary of the United States. From there the plant ranges indefinitely to the southward, occurring generally in rich moist soils or swamps at least to Central America.

PROPAGATION.

Wild millet is easily cultivated and reseeds itself. It requires a moist and preferably a rich soil, as the edge of a marsh or lake, and will grow in water at least a foot in depth. The soil should be broken up (mainly for the purpose of discouraging other plant growth) and the seeds sown thickly in spring. Once established, the plant will take care of itself. The nearer to water it is planted the more available will it be for duck food. It is a splendid plant to use for lowlands that are flooded in winter.

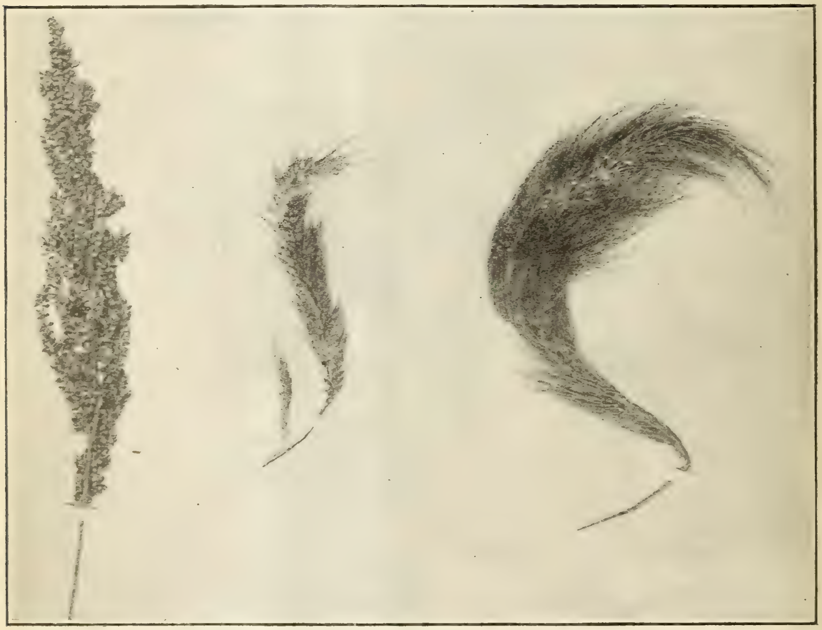
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FIG. 31.—Fruiting heads of wild millet. (One-third natural size.)

The seeds are sold by most seedsmen under the name barnyard grass. A variety has been widely advertised as Japanese barnyard millet or billion-dollar grass. The plant is also known as cockspur grass and sour grass. It may be cultivated in any part of the United States having the proper soil conditions.

THE WATERLILY GROUP.

The waterlily group as represented in the United States is variously considered to comprise from one to three families. One of the three families (Cabombaceæ) is distinguished by having the seeds borne separately, each with its own closely fitting covering; these plants have small uncleft circular or oval leaves on central stalks. The second family (Nelumbonaceæ) has the large acornlike seeds in open cavities in a thick funnel-shaped receptacle; these plants have large uncleft circular leaves on central stalks. The third, or waterlily, family (Nympheaceæ) has the numerous seeds entirely inclosed in a fleshy, leathery, urn-shaped fruit; the leaves of these waterlilies are cleft from the edge to the point of attachment of the leaf stalk.

The Cabombaceæ include two plants of the United States, only one of which is known to have noteworthy value as a wild-duck food. This is the water shield (*Brasenia schreberi*, known also as *B. peltata*, and *B. purpurea*), which is found in ponds and slow streams throughout the United States. Other vernacular names for this plant are frogleaf and little waterlily. The seeds only are eaten, but they have been found in the stomachs of 19 species of ducks, including the wood duck, Florida duck, mallard, black duck, buffle-head, golden-eye, pintail, ruddy duck, widgeon, lesser and greater scaups or bluebills, redhead, ring-necked duck, canvas-back, green-winged and blue-winged teals, white-winged and surf scoters, and shoveller. No fewer than 120 seeds of water shield were found in a single stomach of a mallard, and 380 in one of a wood duck.

The family of nelumbos, or lotuses, has only one native species (*Nelumbo lutea*) in the United States, and it is locally distributed almost throughout the eastern half of the country. This plant has a variety of vernacular names, among which are water chinkapin, wankapin, yankapin, duck acorn, rattle or water nut, and yawknut, and, among the French-speaking people of Louisiana, vole and grand ovale. Locally it has considerable repute as a food for wild ducks, especially the wood duck.

The third, or waterlily, family consists of two genera, the cowlilies or spatterdocks (*Nymphæa*) and the true waterlilies (*Castalia*. The name *Nymphæa* long was applied to the latter group and is yet by some authorities. It is customarily used in this sense also in trade publications. The spatterdocks have yellow flowers with five or six leathery sepals, and the petals though numerous are inconspicuous. The waterlilies, on the other hand, have numerous conspicuous petals, which in our species are white, pink, blue-striped, blue, or yellow.

The spatterdocks, known also as pond, cow, toad, frog, dog, horse, or beaver lilies, beaver-root, and bonnets, are held to comprise 17 species distributed throughout North America, the best known of which is *Nymphæa* or *Nuphar advena.* These grow in shallow water of ponds or slow streams. Only the seeds have distinct value as wild-duck food. They have been found in stomachs of the mallard, black duck, pintail, green-winged teal, lesser scaup, and wood duck. No fewer than 160 seeds were in one stomach of the last-named species.

The true waterlilies of the United States belong to seven species. Among their vernacular names are pondlily, water cabbage, and alligator blankets. Seeds of these waterlilies are known to be eaten by the following 13 species of ducks: Wood duck, black duck, Florida duck, pintail, green-winged teal, lesser and greater scaups, redhead, ring-neck, canvas-back, widgeon, shoveller, and golden-eye. Large numbers of seeds found in single birds are 320 in a ring-neck duck, and 200 each in a lesser scaup and a ruddy duck.

PROPAGATION.

All the species of the waterlily group may be propagated either by seeds or rootstocks, and parts for propagating many of them are on the market. All grow in rather shallow, quiet, or slow-moving water, and prefer mucky bottom. The water chinkapin and the spatterdocks sometimes grow in water only a few inches deep, where the leaves and flower stalks stand erect. The true waterlilies, on the other hand, may grow in water six feet deep. The tuberous waterlily is especially valuable, because it will survive temporary drying up of the water body in which it grows. Probably the most valuable species of this group, however, is the banana waterlily, which is here treated in detail.

BANANA WATERLILY.

VALUE AS DUCK FOOD.

The writer has investigated the value of the banana waterlily (*Castalia mexicana*) as a food for wild ducks in only one locality—Lake Surprise, Tex. The proofs of its importance are so great, however, that they should be brought to the attention of American sportsmen. At Lake Surprise the banana waterlily alone made up nearly half of the entire food of the 10 vegetarian species of ducks occuring there at the time. This showing is much more significant from the fact that sago pondweed (*Potamogeton pectinatus*) also was abundant in the lake. The latter plant (see p. 17), in the writer's opinion, is the best all-round duck food in North America, yet at Lake Surprise it furnished somewhat less than 29 per cent of the food of the ducks, in comparison with more than 48 per cent supplied by *Castalia mexicana.*

Thirty-seven canvas-backs collected at Lake Surprise had eaten various parts of this plant to the extent of 71.6 per cent of their diet. This is a second illustration of the unusual phenomenon of the canvas-back's being attracted to shallow water by a highly prized food. Six ring-neck ducks, or blackjacks, made more than 91 per cent of their food of this plant, and two southern black ducks (*Anas fulvigula*) 98 per cent. The following ducks also were feeding on the plant: Mallard, pintail, lesser scaup, redhead, and shoveller. The parts eaten are the rootstocks, stolons, tubers, and seeds. Mr. Charles W. Ward has furnished rootstocks of *Castalia mexicana* from Avery Island, La., with the information that this plant and wild celery (*Vallisneria spiralis*) furnish the bulk of the food of canvas-backs in that locality.

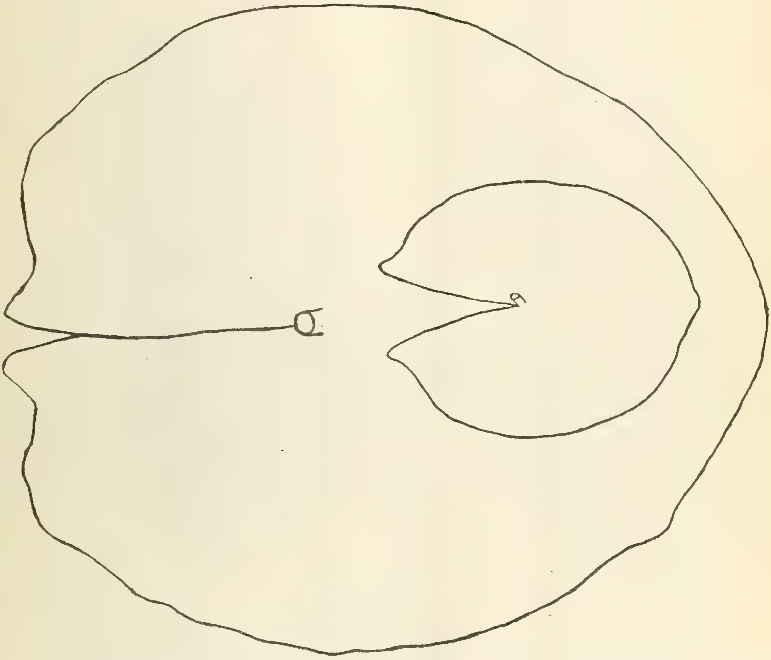

FIG. 32.—Two types of leaves of banana waterlily. (The larger outline half natural size.)

DESCRIPTION OF PLANT.

The banana waterlily is the only native species of the group of true waterlilies (as discussed above) that has yellow flowers. But the leaves and flowers of this species may either float on the surface of the water or stand a few inches above it. The leaves are green above with brown mottlings and vary from greenish to purplish red below with small black markings. The edges of the cleft of the leaf are either somewhat separated or overlapping (fig. 32). The plant springs from an upright rootstock (fig. 33) which bears some resemblance to an unopened pine cone. The rootstocks vary in size up to 2 inches thick and 12 inches long. The smaller ones (at least up to $1\frac{3}{4}$ inches long by three-fourths of an inch thick) are swallowed by ducks.

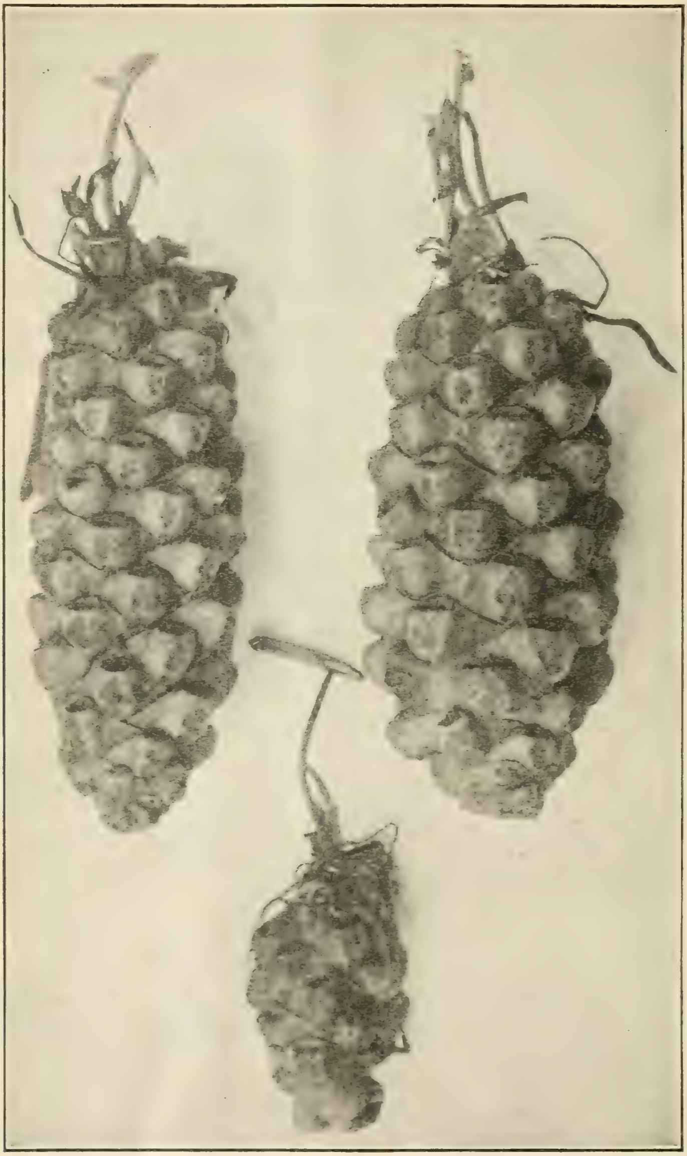

FIG. 33.—Small rootstocks of banana waterlily. (Natural size.)

Tender white stolons or runners extend in various directions from the rootstock. These runners are from a quarter to half an inch in diameter. During the active growing season they give rise to new plants, but in autumn they form peculiar hibernating bodies. These consist of the short modified tip of the stolon, which bears several (1 to 7) upwardly directed buds on one side and a cluster (2 to 17) of thick tuberlike roots on the other. The appearance of these (fig. 34) is strongly suggestive of a miniature " hand " of bananas, and for this reason the name banana waterlily has been proposed for this plant, which has no distinctive vernacular appellation. The name has the additional merit of suggesting the yellow color of the tubers and of the flowers.

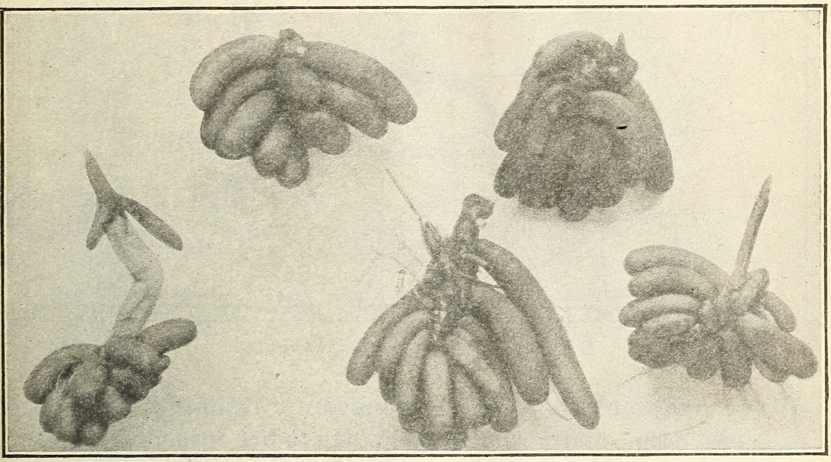

FIG. 34.—Hibernating bodies of banana waterlily. (Two-thirds natural size.)

DISTRIBUTION.

The banana waterlily has been known chiefly as a native of Florida, and the plants of that State have long gone under the name *Castalia flava.* Plants identified from a few localities in Mexico and from Brownsville, Tex., have been called *C. mexicana.* Dr. H. S. Conard, who has monographed the genus,[1] unites these species, as he is fully justified in doing, on the basis of their possession in common of characters unique among waterlilies. The new records of the plant from Galveston, Tex., and Avery Island, La., go far toward bridging the previous apparent gap in distribution of the plant and toward corroborating Dr. Conard's views. The accompanying map (fig. 35) shows the probable natural range of the species along the Gulf coast and in Mexico.

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[1] Publication No. 4, Carnegie Institution, 1905.

PROPAGATION.

Although the banana waterlily is native to only a small portion of the United States, it can be successfully grown over practically the whole country. The plant has long been familiar in cultivation and is sold by most dealers in ornamental aquatics. The waterlily expert of one of the largest firms in the United States reports that *Castalia mexicana* is perfectly hardy as far north as New York City when covered with a foot of water, and he believes that if covered with 2 feet of water it would be hardy at Boston.

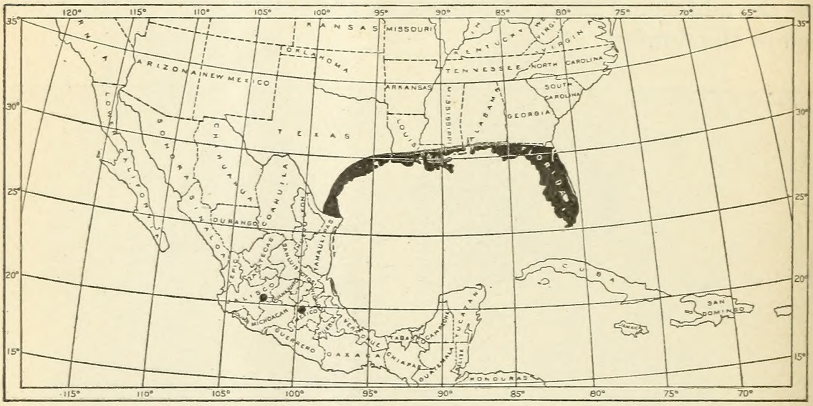

FIG. 35.—Range of banana waterlily.

The banana waterlily needs an abundance of sunlight, water from 1 to 3 feet deep,[1] and a mud bottom. It is not injured by a trace of salt, as is shown by its growing in lakes very near the coast. The rootstocks may be planted by weighting them with stones and dropping where desired. Having great vitality, they may be shipped with only moderate precautions to prevent them from drying, and may be transplanted at almost any time of the year.

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[1] When established it will spread to places where the water is even 5 feet deep.

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